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UPPER TIME LIMIT, ITS GRADIENT CURVATURE AND MATTER

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Abstract: Einstein equation of Gravity has on one side the momentum energy density tensor and on the other, Einstein tensor which is derived from Ricci curvature tensor. A better theory of gravity will have both sides geometric. One way to achieve this goal is to develop a new measure of time not as a coordinate but as a scalar field that will be independent of the choice of coordinates. One natural nominee for such time is the upper limit of measurable proper time measured along the longest geodesic curve from near the "big bang", either as a set of events or as a singularity, to any event. By this, the author constructs a scalar field of an upper limit of measurable time. Time, however, is measured by material clocks. What is the maximal time, that can be measured by a small microscopic clock, when our curve starts near the "big bang" - event or events - and ends at an event within the nucleus of an atom ? Will our tiny clock move along geodesic curves or will it move along a non geodesic curve within matter ? It is almost paradoxical that a test particle in General Relativity will always move along geodesic curves but the motion of matter within the particle, may not be geodesic at all. For example, the ground of the Earth does not move at geodesic speed. Where there is no matter, we choose a curve from near "big bang" event or events, to an event such that the time measured is maximal. The gravitational field, causes that more than one such curves intersect at events, which could results in discontinuity of the gradient of the scalar field of time. The discontinuity can be avoided only if we give up on measurement along geodesic curves where there is matter. In other words, our tiny test particle clock will experience force when it travels within matter.

Keywords: Time;Foliation;Field Curvature;General Relativity;Quantum Gravity;Ashtekar Variables

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1. Introduction

A) The principles of the presented theory

All the following paper is an improvement of an early paper [1].

- If spacetime is homotopic to either a single creation event or to a set of creation events from which we can say the cosmos started its expansion, then maximal proper time curves can be drawn between that event and any other event and therefore attach a time value to any event in space time. Intersections of such curves, however, prevent the global use of a single curve as a time coordinate but does not prevent definition of such time as a scalar field. Although the big bang is either a singularity event or singularity initial events, it is impossible that unbound time can be measured from an event backwards to near big bang. Such unbound measurement is inconsistent with any physical reality. Along these curves, we can imagine a tiny clock that travels and measures time. It is an important point that not the time is a field, but its upper measurable value by a clock particle is, see [2] for Sam Vaknin's idea of Chronon.
- A new principle of equivalence and an anecdote of gradient continuity: The gradient of the upper limit of measurable time from an event, back to near big bang - event or events - is continuous. Clock tick is different under space location due to gravity. The scalar field therefore, has a significant gradient by space. Where there is matter, however, different upper-limit-of-measurable-time curves may intersect. Therefore, at intersection events, the gradient of the scalar field can't be parallel to all of the curves. The result of this short argument is that a test particle moving along an-upper-limit-of-measurable-time-curves will not undergo parallel translation and will be non-geodesic near matter. This fact is a strong motivation to offer an intrinsic curvature operator of the gradient of the upper limit of measurable time as equivalent to matter.
- The definition of event: The paper does not deal with a description of the coordinate of time. The coordinate of time is not subject to any equations! The upper limit on measurable time from the past to an event is subject to such

equations because it is measured by material clocks and material clocks are influenced by space-time curvature and by forces. The main problem is that any particle that has mass, experiences a different trajectory under the same force. To say that the geometry of the trajectory has a physical meaning, we must accept that either there is a unique particle that can interact with any material field e.g. [2] or to give a definition of an event that is consistent with this theory as related to non-gravitational acceleration.

Definition: We will define an event as a non-gravitational interaction or more precisely as a collision. A satellite Fly-by interaction is therefore not considered as an event unless magnetic field is involved and the motion within matter is taken into account.

- The laws of Nature will never directly involve any absolute upper time limit. Instead, we will be coerced to define them by using the gradient of such time, which is indeed local. This point is crucial to the understanding of the paper.
- The apparent shortcoming of this paper is that on one hand it talks about particles but on the other, it tries to avoid discussion of quantum field theory, however, the main subject of the paper is the phenomenological non geodesic movement of an interacting particle that measures an upper limit of time to an event. The classical description of the geometry of the particles trajectory and its relation to the existence of mass does not require Quantum Mechanics. Nevertheless, the idea of quantum coupling between an upper limit of measurable time, and how much matter is present where this upper limit is measured, is discussed as a natural possibility of the presented theory.
- A nice, though less important issue, is that local foliation of space time into 3+1 dimensions requires time orthogonality unlike in Kerr solution. This idea will also be addressed though it is a bit speculative.

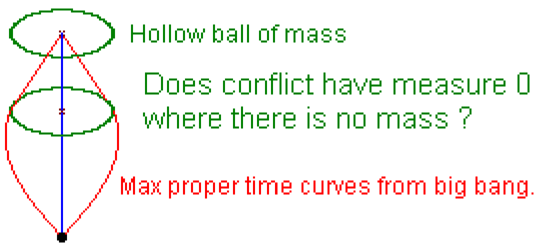
Classical or quantum matter: The gradient need not be parallel to any geodesic curve due to force interactions, avoiding singularities:

Our strategy now will be to understand, why are forces needed where there is mass?

We will see that without such forces, the previously mentioned "anecdote of gradient continuity " can't hold. The direction in space time of the maximum proper time forms a geodesic curve but not necessarily the gradient of the field is parallel to a geodesic

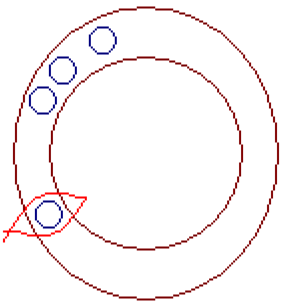
curve because 1) more than one curve can reach the same event 2) at that event, force will cause any test particle clock to move along non geodesic curves (see Appendix B for understanding the role of forces) and 3) A real world particle clock will not move along geodesic curves within matter, otherwise its measurement will result in discontinuities or singularities of the gradient of the upper limit of measurable time. The idea of such particle clocks is not quite new [2] and is important for the action operator that will be presented in order to have physical meaning. Good examples of discontinuity are the center and edge of a hollowed ball of mass. Due to General Relativity, the clock ticks in the gravitational field of the ball are slower than far from the ball. As a result, max proper time geodesic curves from say "big bang" - event or events - must come from outside the ball into the ball. The time at the center of the ball is also a geodesic curve but it is in the time direction in Schwarzschild coordinates due to symmetry. The vector field of the lines is therefore discontinuous and we may have a non zero [3] Euler number of the gradient of the upper limit of measurable time. As was already mentioned, one way to resolve such singularities is that our particle clock will experience force. Space-time in a hollow ball of mass is conic i.e. the Schwarzschild metric coefficient g_{rr} of dr is greater than 1, and is flat but with a zero measure singularity of the Gaussian curvature at the center which is the tip of 4 dimensional cone. In any case, such force has to be negligible though it should exist and should disallow geodesic movement in the sub atomic scale that will otherwise manifest the gradient singularity.

(Fig. 1) The line of the max proper time field from "big bang" - event or events - is discontinuous in the middle of a hollowed ball of mass and therefore a real world clock will not move along geodesic curves at such points no matter how negligible is such an effect.



The "anecdote of gradient continuity" can hold in the sub-atomic level by forces that prevent any microscopic real world clock from moving along geodesic curves. Our field sets an upper limit to measurable time by any such tiny clock particle. The conflict without the existence of forces is apparent also on the edges of the ball because matter is granular, that is to say that the mass is not evenly distributed. Particles measuring absolute maximum proper time from “big bang” - event or events - along curves that enter the ball, must pass through the walls of the ball or hyper-cylinder in 4 dimensions. Therefore, gravitational lenses are formed and events in the hollowed part of the ball are accessible by more than one curve. These singularities can be resolved too if any real world particle-like clock will not move along geodesic curves in the microscopic vicinity of matter, e.g. due to Casimir/Casimir Lifshitz [4] and thus the gradient will be smoothed.

(Fig. 1A) On the edges, gravitational lenses due to granularity cause the geodesic conflicts. The particles form an obstacle that is bypassed by the entering curves.



Also in this case, the new set of gradient conflicts (at absolute maximum proper time intersection events) can be avoided by forces exerted on the clock. If we say that matter is measured by such conflicts/intersections of time gradients , then the fact we also have a microscopic though negligible geodesic conflict in the center of the ball and the "anecdote of gradient continuity" attest to some non-locality of the energy of matter. Weak force fields out of known boundaries of matter are yet to be experimentally found. We will call them “Secondary Dark Matter", “secondary”, because it is not the regular notion of warm or cold dark matter that is often mentioned in astrophysics. In big words, the theory that is behind this paper says that

indeed, laws of physics are local but the entire geometric context has influence on a new effect we have just named, “Secondary Dark Matter”. Contrary to the absolute maximal proper time from "big bang" - event or events - measured by a microscopic clock, most geodesic curves - though they also use travelling clocks - usually measure only local maximum proper time. The curves along which the upper limit on measurable time is measured usually have tangents that point to a 4-direction in space time along which the time changes. In free of matter space, in perpendicular to the (Lorentzian) direction of the gradient, the differential should be zero. Therefore, in geodesic coordinates such that the time is parallel to one of the absolute maximum proper time curves, the mixed terms of the metric tensor vanish. Locally, the separation between space and time works also in metrics such as the Kerr metrics and time appears perpendicular to 3D space manifolds along the maximum proper time curves, e.g. in a set of rotating reference frames. Separation of space and time is important and can be achieve at least locally also along closed time-like curves, however, this paper has a much higher priority motivation, to get an equation that depends only on geometry. To show that time is an emergent dimension is not the issue of this paper.

B) Open questions – local emergent time unsolved issue The question is: Can inverted logic work ? By minimizing an action operator on three dimensional manifolds, can a degree of freedom yield multiple solutions for the metric tensor, such that:

1) The action can serve as a local homotopy [5] parameter.

2) The action will be invariant under Lorentz - like rotations in the resulting four dimensional manifold. This question, to the author’s opinion justifies further research although foliation of space-time works only locally. We would like to describe the curvature of the gradient of the upper limit of measurable time that is measured by our material microscopic particle-like clocks and show its possible relation to Ricci curvature and to Einstein's tensor. The idea is that the gradient of the upper limit of time from an event back to near "big bang" - event or events - forms curves that have

non vanishing curvature where there is matter. Again, it is important to say these gradients are local and that our time is an upper limit on all possible tiny test particles. We now proceed to the measurement of the trajectory curvature of our test particles. We need to develop tools to deal with such curvature as was already presented in a previous paper [1]. In appendix C it will be shown that this curvature can be seen as non-gravitational acceleration.

Intuitive discussion about the second power of curvature of a conserving vector field and about "bending energy".

In special relativity, the square norm of a normalized 4-velocity of a particle is constant $N^2 = u_i u^i = 1$ written in tensor formalism. Also $N^2,_k = (u_i u^i),_k = \frac{d(u_i u^i)}{dx^k} = 0$ such that $u^i = \frac{dx^i}{Cd\tau}$ such that x^i denotes the coordinates and C is the speed of light. If we want to express the curvature of a particle's trajectory when force is exerted on the particle then we can't use derivatives of $N^2 = u_i u^i = 1$ to express that curvature. However, if τ is a scalar field, measuring the upper limit of measurable proper time from near "big bang" singularity event or starting events, to any event, then its derivatives form a vector field. This vector field will not be always geodesic if there are locations in space time where real forces are exerted on any particle, e.g. in matter's vicinity. So $N^2 = \tau_i \tau^i$ such that $\tau_i = \frac{d\tau}{dx^i}$ may offer a way to achieve $N^2,_k \neq 0$. The reader can find the origin of this work in [6] and especially of the use of an early "Bending Energy" operator. So let us begin. We will now define what the Square Curvature or conserving-field-curvature of a vector field V in R^n, with positive definite Euclidean -geometry, is. The formalism will not be tensor but don't worry about that because in most of the paper, full tensor formalism is inevitable. The same formalism is easily extended to Riemannian geometry. We also define Bending Energy as the Square Curvature multiplied by the square norm of the gradient of a scalar field. We would like the field

V to reduce or increase its differential in directions that are perpendicular to the direction of the field. This requirement is also comprehensible when the metric tensor of a manifold with coordinates in R^n has only positive eignevalues in local orthogonal coordinates and we shall see that the operator that describes Field Curvature has quite the same formalism in Riemannian manifolds. We will start with an intuitive description of the operator and later give a proof it is the square curvature of the conserving (here it simply means a gradient of a scalar field) vector field. Given two infinitesimally close points in R^n, $q1$ and $q2 = q1 + hV$ for some infinitesimal h, we would like that $V(q2) - V(q1)$ will be as parallel as possible to the field $V(q1)$.

By Pythagoras it can be written as the following problem to locally minimize

$$\left((\frac{V(q2)-V(q1)}{h}) \bullet (\frac{V(q2)-V(q1)}{h}) - ((\frac{V(q2)-V(q1)}{h}) \bullet \frac{V(q1)}{|V(q1)|})^2 \right) h^2 \qquad \textbf{(1)}$$

When $\bullet$ is the inner product in R^n.

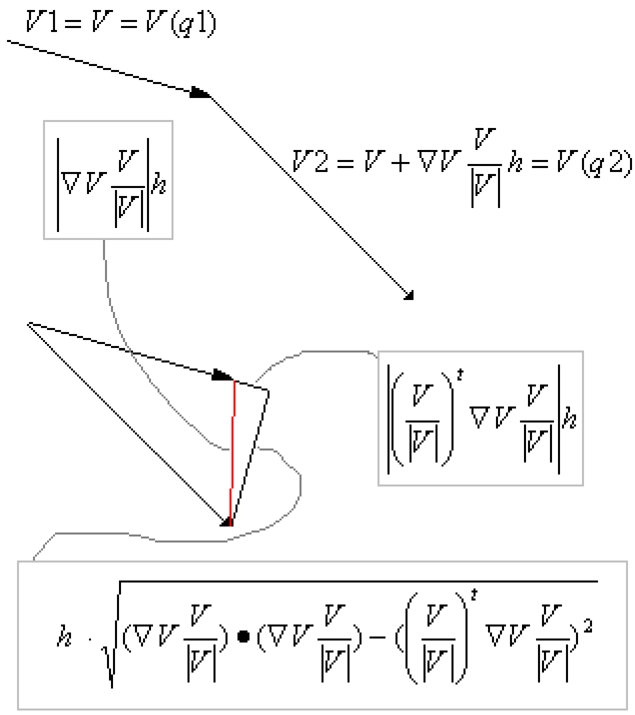
Here $(V(q2)-V(q1)) \bullet \frac{V(q1)}{|V(q1)|}$ represents the projection of the derivative matrix of the vector field $V(q)$ multiplied by the field direction in space.

In other words, since h^2 is arbitrarily small, our objective is to minimize,

$$\begin{aligned} &(\nabla V \bullet \frac{V}{|V|}) \bullet (\nabla V \bullet \frac{V}{|V|}) - (\left(\frac{V}{|V|}\right)^t \bullet \nabla V \bullet \frac{V}{|V|})^2 = \\ &\frac{(\nabla V \bullet V) \bullet (\nabla V \bullet V)}{V \bullet V} - (\frac{V^t \bullet \nabla V \bullet V}{V \bullet V})^2 \end{aligned} \qquad \textbf{(2)}$$

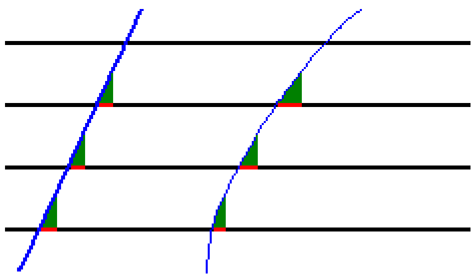
Here ∇V means the matrix $a_{i\,j} = \frac{\partial V_i}{\partial X^j}$ in its non covariant form.

(Fig. 2) – "Bending Energy" which is the Field Curvature multiplied by the squared norm of the gradient and its Euclidean geometric meaning – informal description is, how much the field changes in direction perpendicular to itself.



The following next figure shows us two curves one on the left for which "Bending Energy" *BE* is zero and one on the right for which *BE* is positive:

(Fig. 3) - Parallel deviation on the right.



2. Tensor formalism of the Square Curvature of a conserving field

How can we measure, how much the gradient of the upper limit on measurable time from an event back to near "big bang" event or events, bends, i.e. force on particles measuring such time, is exerted in matter ? As will be discussed, in tensor formalism, derivatives are replaced by covariant derivatives and are denoted by semi colon ";"

and derivatives by comma ",".

For example the covariant derivative of the vector field V_λ by the coordinate dx^μ ,

is written, $V_\lambda;_\mu = \frac{dV_\lambda}{dx^\mu} - \Gamma^k_{\lambda\mu} V_k = V_{\lambda},_\mu - \Gamma^k_{\lambda\mu} V_k$ where $\Gamma^k_{\lambda\mu}$ denotes the upper Christoffel symbols . Upper and lower indices represent the covariant and contra-variant properties and upper and lower indices sum according to Einstein convention so (2) can be written as a tensor density with local coordinates in R^n. In this paper, often the gradient of a scalar field P by the coordinate x^μ, $\frac{dP}{dx^\mu}$ will be replaced by P_μ. Regarding the square root of the determinant of the metric tensor $\sqrt{-g}$, so following are tensor densities [7], that yield tensor equations [8],

$$SquareCurvature \equiv \frac{1}{4}\left(\frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mathrm{m} (\mathrm{P}^s \mathrm{P}_s),_\mathrm{k}\, g^{mk}}{(\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i})^2} - \frac{((\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mathrm{m} \mathrm{P}^m)^2}{(\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i})^3} \right)\sqrt{-g} \text{ or} \qquad \textbf{(3)}$$

that can be written as $\frac{1}{4}\left(V_\mathrm{m} V^m - (\frac{1}{\mathrm{t}})^2 \right)\sqrt{-g}$ for $V_m = \frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mathrm{m}}{\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i}}$ and

$\frac{1}{t} = \frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mathrm{m} \mathrm{P}^m}{(\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i})^{3/2}}$. Don't' confuse the scalar function t with maximum proper time.

We choose a simpler expression for our absolute maximum proper time from "big bang" event or events, namely τ , and where there is no matter in space-time, we expect one of the following to be true.

$$\boxed{P = \tau, P \text{ is real}} \qquad \textbf{(4)}$$

or

$$\boxed{PP^* = \tau^2 \psi\psi^*, P = \tau\psi \text{ is complex}} \qquad \textbf{(5)}$$

Important: Please note that $SquareCurvature(P) = SquareCurvature(kP)$ for constant k. This fact attests to the intrinsic geometric trajectory curvature that (3) represents. Please note that in the model presented in (5), the time τ is coupled with a wave function ψ and there is only a need for $P = \tau\psi$ to have 3rd order derivatives but not for τ alone. For the reason of coupling please refer to T. Banks, Willy Fischler

page 7, [9]. An intuitive idea behind the coupling $\tau\psi$ is that ψ tells us in Quantum Mechanics language, how much matter there is where the upper limit τ can be measured. This approach is different than the philosophy behind Richard Feynman's path integrals. Development of (3) can be from the following:

$$\boxed{\begin{aligned} L &= \frac{1}{4}\left(\frac{(P^\lambda P_\lambda),_m (P^s P_s),_k g^{mk}}{(P^i P_i)^2} - \frac{((P^\lambda P_\lambda),_m P^m)^2}{(P^i P_i)^3}\right) = \frac{1}{4}U^j U_j \\ U_m &= \frac{(P^\lambda P_\lambda),_m}{P^i P_i} - \frac{(P^\lambda P_\lambda),_\mu P^\mu}{(P^i P_i)^2} P_m \end{aligned}} \quad \textbf{(6)}$$

The unique properties of (6) as an intrinsic geometric operator that does not depend on the parameterization of the curves formed by P_λ, can be seen in the following,

we can write $U_m = \frac{N^2,_m}{N^2} - \frac{N^2,_\mu P^\mu}{N^4} P_m$ *s.t.* $N^2 \equiv P^i P_i$ (also found as Z in this paper) we can sloppily omit the comma for the sake of brevity the same way we write

P_i instead of $\mathrm{P},_\mathrm{i}$ and instead of $\frac{dP}{dx^i}$ and write $U_m = \frac{N^2{}_m}{N^2} - \frac{N^2{}_\mu P^\mu}{N^4} P_m$. Suppose that we replace P by $f(P)$ such that f is increasing with p, then

$f(P)_i \equiv \frac{df(P)}{dx^i} = \frac{df(p)}{dp}\frac{dP}{dx^i} = f_p(P)P_i$. Let $N^2 \equiv \mathrm{P}^\lambda \mathrm{P}_\lambda$ then we can write

$\hat{N}^2 \equiv f(P)_\lambda f(P)^\lambda = N^2 f_p(P)^2$ and $\frac{\hat{N}^2{}_k}{\hat{N}^2} = \frac{N^2{}_k}{N^2} + \frac{2f_{pp}(p)}{f_p(p)} p_k$ but also

$$\begin{aligned} &\hat{U}_k = \frac{\hat{N}^2{}_k}{\hat{N}^2} - \frac{\hat{N}^2{}_s}{\hat{N}^2}\frac{f_p(p)p^s f_p(p)p_k}{\hat{N}^2} = \\ &\frac{N^2{}_k}{N^2} + \frac{2f_{pp}(p)}{f_p(p)} p_k - \left(\frac{N^2{}_s}{N^2} + \frac{2f_{pp}(p)}{f_p(p)} p_s\right)\frac{f_p(p)p^s f_p(p)p_k}{N^2 f_p(p)^2} = \\ &\frac{N^2{}_k}{N^2} - \frac{N^2{}_\mu P^\mu}{N^4} P_k = U_k \end{aligned} \qquad \textbf{(6.1)}$$

and $L = \frac{1}{4}U^j U_j = \frac{1}{4}\hat{U}^j \hat{U}_j$ and

$$SquareCurvature(P) = L\sqrt{-g} = SquareCurvature(f(P))$$

Obviously $U_m P^m = 0$. The vector U_m describes the direction and intensity of the

curvature of the field P_λ which is a change perpendicular to P^m.

3. Classical non-relativistic limit - passive acceleration energy difference

It will be shown in appendix C that the non-relativistic classical limit of our square curvature of the gradient of upper limit of measurable time back to near "big bang" event or events should be α^2/C^4 where $\alpha^2 = (a_x \pm g_x)^2 + (a_y \pm g_y)^2 + (a_z \pm g_z)^2$ where (g_x, g_y, g_z) denotes the classical gravitational acceleration g and (a_x, a_y, a_z), denotes acceleration by material fields, C is the speed of light. x, y, z are the three dimensional coordinates. That gives a special meaning to (3) as describing a non-geodesic acceleration field. This offers a nice test to this theory. Suppose we have a rigid ball of mass with evenly distributed mass density. We do not know the non-gravitational acceleration that a clock particle undergoes in matter so α^2 is unknown but due to Einstein's principle of equivalence we do know that a particle resting on the ball or in the ball is actually accelerated. A non-relativistic classical acceleration a can be with the direction of gravitational acceleration, opposite to it or perpendicular, so averaging these accelerations, we can write an approximation

$$\alpha^2 = ((a_x - g_x)^2 + (a_y - g_y)^2 + (a_z - g_z)^2 + (a_x + g_x)^2 + (a_y + g_y)^2 + (a_z + g_z)^2 + 4(a^2 + g^2))/6 = (a_x{}^2 + a_y{}^2 + a_z{}^2) + (g_x{}^2 + g_y{}^2 + g_z{}^2)$$

Such that $a^2 + g^2$ accounts for perpendicular $a = (a_x, a_y, a_z), g = (g_x, g_y, g_z)$.

Or in a more illuminating language $\alpha^2 = ((a+g)^2 + (a-g)^2)/2 = a^2 + g^2$. If the integration over volume of α^2 is preserved then g^2 should be proportional to the potential gravitational pseudo energy. $(g_x{}^2 + g_y{}^2 + g_z{}^2)/C^4$ is a non-relativistic limit of curvature of the gradient of time because in the special theory of relativity 4-acceleration is a curvature vector and the time component of that vector is very small in the non-relativistic limit. Let us integrate $(g_x{}^2 + g_y{}^2 + g_z{}^2)/C^4$ in our ball. Suppose our ball has a radius r_0 and a volume $V = \frac{4\pi}{3} r_0{}^3$ and a mass M and that

our gravitational constant is K. So it's density is $\frac{M}{V}=\frac{M}{\frac{4\pi}{3}{r_0}^3}$ then the integration

yields: $\frac{1}{C^4}\int_0^{r_0}\left(\frac{K(\frac{M}{V}\pi r^3)}{r^2}\right)^2 4\pi r^2 dr=\frac{K}{C^4}(\frac{3}{5}\frac{KM^2}{r_0})$, however, if we integrate the negative gravitational potential energy of the ball we have $\int_0^{r_0}\left(\frac{K(\frac{M}{V}\pi r^3)}{r}\right)4\pi r^2\frac{M}{V}dr=(\frac{3}{5}\frac{KM^2}{r_0})=-E_g$ so we have

$\int_{volume}\frac{({g_x}^2+{g_y}^2+{g_z}^2)}{C^4}dVolume=-\frac{K}{C^4}E_g$ but that suggests the following:

$$L=\frac{1}{4}(\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}(\mathrm{P}^{s}\mathrm{P}_{s}),_{\mathrm{k}}g^{mk}}{(\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^2}-\frac{((\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}\mathrm{P}^{m})^2}{(\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^3})=\frac{1}{4}U^jU_j=\frac{K}{C^4}\rho C^2 \qquad \textbf{(6.2)}$$

Where ρC^2 is the energy density and ρ is the mass density.

In general, $\frac{\alpha^i}{C^2}=\frac{d^2x^i}{(C^2d\tau)^2}$ which is the 4-acceleration expressed in length units.

4. Classical non-relativistic limit – predicted small acceleration of uncharged particles in an electric field

If the energy of matter is indeed expressible as non-geodesic movement of particles measuring the upper limit of measurable proper time, then we can use the classical limit which is a non-gravitational acceleration field even in an electric field.

In other words, since the energy density of a static electric field is $\frac{\varepsilon_0}{2}E^2$ such that ε_0 is the permittivity constant and E^2 is the square norm of the electric field.

$$\frac{\varepsilon_0}{2}\int_{\Omega}E^2 dVolume=Energy \qquad \textbf{(6.3)}$$

We can easily see that our curvature 4-vector $U_m = \frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}}{\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}}} - \frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mu}\mathrm{P}^{\mu}}{(\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^2} P_m$ such that $P = \tau$ the upper limit of measurable time to an event, is perpendicular to the unit 4-vector $\frac{\mathrm{P}_{\lambda}}{\sqrt{\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}}}}$ and that $\frac{\mathrm{P}_{\lambda}}{\sqrt{\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}}}}$ is expressible by derivatives by length so we have an approximation in the non-relativistic classical limit by $K\rho C^2 = \frac{1}{4} U_m U^m \approx \frac{\alpha^2}{C^4}$ as we saw. Where ρC^2 is the energy density and K is the gravitational constant and α is an acceleration by a force field, expressing a non-geodesic motion of a particle measuring the upper limit of measurable time up to an event. So we can write

$$\frac{K\varepsilon_0}{2C^4} E^2 \approx \frac{\alpha^2}{C^4} \Rightarrow \sqrt{\frac{K\varepsilon_0}{2}} E \approx \alpha \qquad \mathbf{(6.4)}$$

Such an effect is measurable and is expected on uncharged particles. (6.4) Yields $1.71888777 * 10^{-11} \mathrm{Metre}^2 * \mathrm{Volt}^{-1} * \mathrm{Second}^{-2}$. It takes 1000000 Volts over a gap of 1mm to expose an acceleration field of 1.71888777 cm/sec^2 which depends on mass and yet is not the signature of gravity. It is possible to create very strong electric field densities by using relatively low voltage and by using conducting board and a cone to achieve a high gradient of the square norm of the electric field $\frac{d}{dx^i} E^2$ and this field is known to a achieve the phenomenon of Dielectrophoresis [10]. By subtracting the force F_{DEP} caused by Dielectrophoresis from the total force F on a ball of matter in a strong electric field we would expect

$$\sqrt{\frac{K\varepsilon_0}{2}} E m_0 \approx F - F_{DEP} \qquad \mathbf{(6.5)}$$

Where m_0 is the mass of a ball in the electric field. It is much more difficult to achieve high values of E in homogenous fields even when electric potentials of millions of volts are applied. (6.5) has evidence in the experiment by T. Datta, M. Yin, A. Dimofte [11], however, this experiment was done with metal balls in which the

surrounding field caused induced dipoles to appear. The Fly-By Anomaly [12] is probably also related to a very same interaction with Earth magnetic field.

5. Classical non-relativistic limit – tidal force

If a metal rod is suddenly exposed to a very strong non-uniform gravitational field, the rod may break due to tidal forces. So we may think that our definition of an event as a non-gravitational interaction is wrong. However, the rod experiences tidal forces due to chemical and covalent bonds which are the reason for its non - geodesic motion and therefore the tidal rod experiment doesn't violate our definition of an event as a non-gravitational interaction.

6. The equation of gravity

Although QFT is not the subject of this paper, it is worth mentioning [9] and especially that the meaning of $U_m \neq 0$ is the Unruh effect. Also see Appendix C in this paper which presents the link between the pair U_m and $\frac{P_\lambda}{\sqrt{P^i P_i}}$ and Minkowsky rotations. We continue from the minimum action of

$$\boxed{\begin{array}{l} Z = N^2 = P_\mu P^\mu \text{ and } U_\lambda = \frac{Z_\lambda}{Z} - \frac{Z_k P^k P_\lambda}{Z^2} \text{ and } L = \frac{1}{4} U^k U_k \\ R = Ricci \text{ curvature.} \\ Min\ Action = Min \int_\Omega \left(\frac{1}{2} R - 8\pi L \right) . \sqrt{-g}\, d\Omega \end{array}}$$

See Appendix A, for the most general equation, using Einstein Tensor

$L = \frac{1}{4} U_i U^i$ and $\mathrm{Z} = \mathrm{P}^{\mathrm{k}} \mathrm{P}_{\mathrm{k}}$

$$\frac{8\pi}{4}\begin{pmatrix} +2((\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}} P^m}{Z^3} P^k);_k - 2(\frac{Z^m}{Z^2});_m) P_\mu P_\nu + \\ +2\frac{(P^{\lambda} Z_{\lambda})^2}{Z^3}\frac{P_\mu P_\nu}{Z} - 2\frac{Z^{\lambda} Z_{\lambda}}{Z^2}\frac{P_\mu P_\nu}{Z} + \\ +U_\mu U_\nu - \frac{1}{2} U_{\mathrm{k}} U^k g_{\mu\nu} \end{pmatrix}. = \qquad \textbf{(7)}$$

$$\frac{8\pi}{4}(U_\mu U_\nu - \frac{1}{2} U_{\mathrm{k}} U^k g_{\mu\nu} - U^k;_k \frac{P_\mu P_\nu}{Z}) = R^{\mu\nu} - \frac{1}{2} R g^{\mu\nu}$$

as we shall see later, if we consider variation by P^μ and by $g^{\mu\nu}$ and their derivatives and do not explicitly regard $P = \tau$ then a simple solution

$W^{\mu\nu} = U^k;_k \frac{P_\mu P_\nu}{Z} = 0$ to the Euler Lagrange equations yields

$$(\frac{Z^m}{Z^2});_m - (\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}} P^m}{Z^3} P^k);_k = -(\frac{Z^{\lambda} Z_{\lambda}}{Z^3} - \frac{(Z_{\mathrm{s}} P^s)^2}{Z^4}) \quad \text{and}$$

$$\boxed{(\frac{Z^k}{Z});_k - (\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}} P^m}{Z^2} P^k);_k = U^k;_k = 0} \qquad \textbf{(8)}$$

and therefore (7) becomes

$$\boxed{\frac{8\pi}{4}(U_\mu U_\nu - \frac{1}{2} U^k U_k g_{\mu\nu}) = R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu}} \qquad \textbf{(9)}$$

and we have $-L = -R$, such that $R_{\mu\nu}$ is the Ricci curvature tensor [13]. [14]. If we ignore (6), and the coming (18)-(24),(34),(35) and (36), it is a bit disappointing that after all the efforts we simply get [13] and [14] which look like an ordinary General Relativity matter-geometry equation. Up to a sign, there is always a way to solve the following equation $\frac{8\pi}{4}(U^\mu U^\nu - \frac{1}{2} U^k U_k g^{\mu\nu}) = \frac{8\pi K}{C^4} T^{\mu\nu}$ in General Relativity constants for an ordinary dust energy momentum tensor and therefore (9) is consistent with existing theories and is an important link to well established work on General Relativity. (9) suggests $\frac{8\pi}{4} U^\mu U^\nu = R^{\mu\nu} \Rightarrow R^{\mu\nu} P_\mu P_\upsilon = 0$ so for sufficiently

small geodesic normal exponential coordinates y_μ such that $\frac{dy_\mu}{d\tau} = p_\mu$, the volume cone in y_μ direction is like the one of flat space since $d\Omega_{SpaceTime} = (1 - \frac{1}{6} R_{ij} y^i y^j + O(|y|^3))d\Omega_{Euclidean}$ so $d\Omega_{SpaceTime} = (1 + O(|y|^3))d\Omega_{Euclidean}$.
To see how (6) is related to spinors [15] see Appendix C. However, (7) offers more interesting fields and (6) is a purely geometric term. We see that curvature of the gradient of upper limit on measurable time is equivalent to Ricci curvature. If that can be true then we have an equation that is based solely on geometry. We have a simple action (without spinors [15] and other advanced mathematical technology) of the form: $V^\lambda V_\lambda - \frac{1}{t^2}$ such that V_λ is a vector field and $\frac{1}{t}$ is also a scalar field. If the definition is in 3 dimensions, it hints at 4 dimensional Lorentzian metric geometry. U_μ is in units of $\frac{1}{Length}$. For the complex square (second power of) curvature operator we set the curvature vector $\hat{U}_\mu = \frac{P_\mu;_i P^{*i}}{\sqrt{(P_k P^{*k})(P^*_L P^L)}} - \frac{P_k;_i P^{*i} P^{*k} P_\mu}{(P_k P^{*k})(P^*_L P^L)}$. Obviously $U_\mu P^{*\mu} = 0$. Bearing in mind that in our case $P_k P^{*k} = \frac{1}{2}(P_k P^{*k} + P^*_k P^k)$ we calculate

$$\frac{1}{2}(\hat{U}_k \hat{U}^{*k} + \hat{U}^*_k \hat{U}^k)\sqrt{-g} =$$

$$SquareCurvature \equiv \left(\frac{\frac{1}{2}((P_i;_j P^{*j})(P^*_k;_L P^L) + (P^*_i;_j P^j)(P_k;_L P^{*L}))g^{ik}}{(P^{*i} P_i)(P^\lambda P^*_\lambda)} - \left(\frac{(P_i;_j P^{*i} P^{*j})(P^*_\mu;_\nu P^\mu P^\nu)}{((P^{*i} P_i)(P^\lambda P^*_\lambda))^{\frac{3}{2}}}\right) \right)\sqrt{-g}$$

(10)

7. Quantum Gravity in a nutshell

The idea that τ is meaningful where a material reference frame can interact with a particle measuring that upper limit of time, requires a formalism of how much matter

there is to "contribute" or influence that measurement as a wave function ψ and that is the idea behind the coupling $PP^* = \tau^2\psi\psi^*$ to denote observer- time measurement coincidence. We would also like to discuss the calculative outcome of this philosophical idea. $\hat{U}_k$ can be written in a more illuminating way as

$$\hat{U}_k \equiv \left(\frac{\hat{N}^2{}_{k}}{\hat{N}^2} - \frac{\hat{N}^2{}_{j}(\tau\psi)^{*j}}{(\hat{N}^2)^2}(\tau\psi)_k \right) \qquad \textbf{(10.1)}$$

Where the index k, means derivative by the coordinate x^k, $\hat{N}^2 = (\tau\psi)_k(\tau\psi^*)^k$ and for the sake of simplicity $N^2 = \tau_k\tau^k$.

We can replace ψ by an eigen-function that depends on τ and write

$$\psi = e^{\frac{-iE\tau}{\hbar}} \text{ s.t. } \mathrm{i} = \sqrt{-1} \qquad \textbf{(10.2)}$$

and where E plays the role of energy of a coupled wave function, so we have

$$(\tau\psi)_k = \tau_k\psi + \tau\psi_k = \tau_k\psi(1 - \frac{i\tau E}{\hbar}) \qquad \textbf{(10.3)}$$

$$\hat{N}^2 = \tau_k\tau^k(1 + \frac{\tau^2E^2}{\hbar^2}) = N^2(1 + \frac{\tau^2E^2}{\hbar^2}) \qquad \textbf{(10.4)}$$

and

$$\frac{\hat{N}^2{}_s}{\hat{N}^2} = \frac{N^2{}_s}{N^2}\frac{(1+\frac{\tau^2E^2}{\hbar^2})}{(1+\frac{\tau^2E^2}{\hbar^2})} + \frac{2\tau\tau_sE^2N^2/\hbar^2}{(1+\frac{\tau^2E^2}{\hbar^2})N^2} = \frac{N^2{}_s}{N^2} + \frac{2\tau\tau_sE^2}{(\hbar^2+\tau^2E^2)} \qquad \textbf{(10.5)}$$

Now we want to calculate $\frac{\hat{N}^2{}_{j}(\tau\psi)^{*j}}{(\hat{N}^2)^2}(\tau\psi)_k$ so we have

$$\frac{\hat{N}^2{}_{j}(\tau\psi)^{*j}}{(\hat{N}^2)^2}(\tau\psi)_k =$$

$$(\frac{N^2{}_j}{N^2} + \frac{2\tau\tau_jE^2}{(\hbar^2+\tau^2E^2)})\frac{(\tau^j\psi^*(1+\frac{i\tau E}{\hbar}))}{(1+\frac{\tau^2E^2}{\hbar^2})N^2}\tau_k\psi(1-\frac{i\tau E}{\hbar})) = \qquad \textbf{(10.6)}$$

$$(\frac{N^2{}_j}{N^2} + \frac{2\tau\tau_jE^2}{(\hbar^2+\tau^2E^2)})\frac{\tau^j}{N^2}\tau_k = \frac{N^2{}_j\tau^j\tau_k}{(N^2)^2} + \frac{2\tau\tau_kE^2}{(\hbar^2+\tau^2E^2)}$$

Now from (10.1), (10.5) and (10.6) we have the result

$$\hat{U}_k \equiv \left(\frac{\hat{N}^2{}_{\mathrm{k}}}{\hat{N}^2} - \frac{\hat{N}^2{}_{\mathrm{j}}(\tau\psi)^{*\mathrm{j}}}{(\hat{N}^2)^2}(\tau\psi)_k \right) =$$
$$((\frac{N^2{}_k}{N^2} + \frac{2\tau\tau_k E^2}{(\hbar^2 + \tau^2 E^2)}) - (\frac{N^2{}_j \tau^j \tau_k}{(N^2)^2} + \frac{2\tau\tau_k E^2}{(\hbar^2 + \tau^2 E^2)})) = \quad \textbf{(10.7)}$$
$$(\frac{N^2{}_k}{N^2} - \frac{N^2{}_j \tau^j \tau_k}{(N^2)^2}) = (\frac{N^2{}_k}{N^2} - \frac{N^2{}_j P^j P_k}{(N^2)^2}) = U_k$$

Therefore if the wave function depends solely on the upper limit of measurable time, (10) is reduced to (3). Now recall (6.1) and we have that replacing $\tau \to \tau\psi \to f(\tau)\psi$ renders (3),(6),(7),(8),(9),(10) invariant. Recall that the upper limit of measurable time can be defined as a limit backwards from any event to near the “big bang” singularity event or events and that τ starts from zero. Now suppose a particle appears as a fluctuation in space time then when looking at the (10.5) additive,

$$\frac{2\tau\tau_k E^2}{(\hbar^2 + \tau^2 E^2)} \cong \frac{2\tau\tau_k E^2}{(\pm\delta\tau)^2 (\delta E)^2} \quad \textbf{(10.8)}$$

we can see that the denominator can't be smaller than $\hbar^2$ for small enough τ and E and since the denominator is in Joule * Second units, the physical meaning of such a denominator can be

$$(\pm\delta\tau)^2(\delta E)^2 = (2\delta\tau)^2(\delta E)^2 = \hbar^2 + \tau^2 E^2 \Rightarrow$$
$$4(\delta\tau)^2(\delta E)^2) = \hbar^2 + \tau^2 E^2 \Rightarrow \quad \textbf{(10.9)}$$
$$(\delta\tau)(\delta E) \geq \frac{\hbar}{2}$$

which is a form of the principle of uncertainty. The change in the direction of the gradient of the time field is due to the need to avoid discontinuity of gradient measurement by particle clocks in max proper time curves intersections .Discontinuity of the gradient is avoided by uncertainty of the intersection events/strings .Then $\psi\psi^*$ could be the probability of the 4-location of such avoided geodesic conflict in the middle of a constellation of particles. The coupling of τ and ψ has an extra important meaning which is that quantum uncertainty resolves the discontinuities of the gradient of τ and prevents its measurement. In the classical model of gravity in this theory, τ is "smoothened out" by the equation (7) or (9) which are an

approximation or a limit of a Quantum effect. The classical model is sufficient for a giving a new description of matter, however, ψ is required for resolving gradient singularities of τ that do not exist in the classical model.

8. Noether's theorem

Zero divergence

Another proof of the divergence conservation is based on the invariance of ζ under scaling of $P_\mu \to P_\mu(1+\varepsilon)$ so $\delta P_\mu = \varepsilon P_\mu$ and by Noether's theorem

$$\frac{d}{dx^\nu}(\varepsilon P_\mu(\frac{4P^\mu Z^\nu}{Z^2} - 4P_k Z^k \frac{P^\mu P^\nu}{Z^3})\sqrt{-g}) = \varepsilon \frac{d}{dx^\nu}(\frac{4Z^\nu}{Z} - 4P_k Z^k \frac{P^\nu}{Z^2})\sqrt{-g}) = \varepsilon 4U^\nu;_\nu = \varepsilon 4Div(U^\nu) = 0$$

which means conservation of the non-gravitational acceleration field exactly as was shown in (8),(23).

9. Vaknin's Chronon fields

A natural question is, given a solution to (7) when is $\zeta = \frac{1}{4}U^k U_k \sqrt{-g}$ invariant under rotations $A_\mu{}^j$ of P_k? By definition, a rotation can be seen as isometrics in Minkowsky space. Less than full isometrics is actually required. We require at first:

$$A_\mu{}^j P_j A_\nu{}^k P_k g^{\mu\nu} = P_\mu P_\nu g^{\mu\nu} = P_k P^k \qquad \textbf{(10.10)}$$

So $Z = N^2 = P_\lambda P^\lambda$ is invariant and therefore also $Z_k = \frac{\partial Z}{\partial x^k}$ is invariant under $\hat{P}_\mu = A_\mu{}^j P_j$. We continue by recalling that,

$$U_k = \frac{N^2{,}_k}{N^2} - \frac{N^2{,}_j P^j P_k}{N^4} = \frac{Z_k}{Z} - \frac{Z_j P^j P_k}{Z^2} \qquad \textbf{(10.11)}$$

We need to find a "rotation" $A_\mu{}^j$ for which $\zeta = \frac{1}{4}U^k U_k \sqrt{-g}$ remains invariant.

Since $U^k U_k = \frac{Z_k Z^k}{Z} - \frac{(Z_j P^j)^2}{Z^3}$ and since Z and Z_k remain invariant, we only

need our "rotation" $A_\mu{}^j$ to keep $Z_j P^j$ invariant. It is sufficient for $A_\mu{}^j$ to be a "rotation" about the Z_j axis that leaves Z_j invariant i.e. $Z_\mu = Z_j A_\mu{}^j$ and $Z_j P^j$ invariant. For $Z^\lambda Z_\lambda \neq 0$, the vector that is rotated is

$$Y_k = \frac{P_k}{\sqrt{Z}} - \frac{Z_\mu Z_k}{Z^\lambda Z_\lambda} \frac{P^\mu}{\sqrt{Z}} \qquad \textbf{(10.12)}$$

And

$$Y_k \frac{Z^k}{Z} = \frac{P_k}{\sqrt{Z}} \frac{Z^k}{Z} - \frac{Z_\mu Z_k}{Z^\lambda Z_\lambda} \frac{P^\mu}{\sqrt{Z}} \frac{Z^k}{Z} = 0 \qquad \textbf{(10.13)}$$

From the invariance of $Z_\mu = Z_j A_\mu{}^j$ and $Z_j P^j$ under the "rotation" $A_\mu{}^j$,

$$\begin{gathered}\hat{Y}_k \frac{Z^k}{Z} = \hat{Y}_k \frac{\hat{Z}^k}{\hat{Z}} = A_k{}^\mu Y_\mu A_s{}^j \frac{Z_j}{Z} g^{ks} = \\ \frac{\hat{P}_k Z^k}{\sqrt{Z} Z} - \frac{Z_\mu Z_k}{Z^\lambda Z_\lambda} \frac{P^\mu}{\sqrt{Z}} \frac{Z^k}{Z} = \frac{P_k Z^k}{\sqrt{Z} Z} - \frac{Z_\mu Z_k}{Z^\lambda Z_\lambda} \frac{Z^k}{Z} \frac{P^\mu}{\sqrt{Z}} = 0\end{gathered} \qquad \textbf{(10.14)}$$

An example condition for rotation is

$$-Y_k = A_k{}^\mu A_\mu{}^j Y_j \qquad \textbf{(10.15)}$$

which reminds of spinors.

Vaknin's Chronon field $A_k{}^\mu$ as defined here can't exist if $P_j = K Z_j$ for some K

Because then $Y_k = \dfrac{K Z_k}{\sqrt{Z}} - \dfrac{Z^\mu Z_k}{Z^\lambda Z_\lambda} \dfrac{K Z_\mu}{\sqrt{Z}} = 0$ and the rotation is degenerated.

$P_j = K Z_j$ also means $U_k = \dfrac{Z_k}{Z} - \dfrac{Z_j P^j P_k}{Z^2} = \dfrac{P_k}{KZ} - \dfrac{P_j P^j P_k}{KZ^2} = 0$.

A necessary condition for Vaknin's Chronon field to exist is therefore

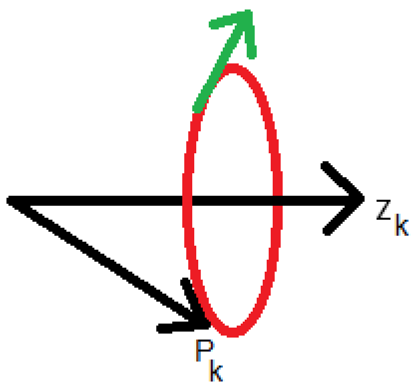
$$A_k{}^\mu \neq \delta_k{}^\mu \Rightarrow U_k \neq 0 \qquad \textbf{(10.16)}$$

Such that $\delta_k{}^\mu$ is the Kronecker delta.

In 1982 Dr. Sam Vaknin laid the foundations of the existence of a Chronon field [2] and also to possible irreversible cosmic expansion. Replacement of P_k by $A_k{}^\mu P_\mu$ leaves ζ invariant but not the curvature vector and therefore influences gravity.

There are other ways to use symmetries in $\zeta = \frac{1}{4}U^k U_k \sqrt{-g}$ to show spin, however, curves along which the upper limit of measurable time is measured and that enter a ball of hollow mass, cause Z_j at the center of the ball point in the Schwarzschild time axis. These clocks must come from the outside because clock ticks are slowed by gravity. In such a case rotation of P_k around Z_j makes physical sense.

(Fig. 4) – Conic rotation



10. Proof that SquareCurvature is the square (to the second power of) conserving field curvature

The square curvature of a conserving vector field is defined by an arc length parameterization t along the curves it forms

$$Curv^2 \equiv \frac{d}{dt}\left(\frac{V_\lambda}{\sqrt{V^k V_k}}\right)\frac{d}{dt}\left(\frac{V_\mu}{\sqrt{V^k V_k}}\right)g^{\lambda\mu} \qquad \textbf{(11)}$$

such that $g^{\lambda\mu}$ is a diagonal unit matrix. For convenience we will write

$Norm \equiv \sqrt{V^k V_k}$ and $\dot{V}_\lambda \equiv \frac{d}{dt}V_\lambda$. For arc length parameter t. Let W_λ denote:

$$W_\lambda = \frac{d}{dt}\left(\frac{V_\lambda}{\sqrt{V^k V_k}}\right) = \frac{\dot{V}_\lambda}{Norm} - \frac{V_\lambda}{Norm^3}V_k \dot{V}_\nu g^{k\nu} \qquad \textbf{(12)}$$

Obviously

$$W_\lambda V_k g^{\lambda k} = \frac{\dot{V}_\lambda V_k g^{\lambda k}}{Norm} - \frac{V_\lambda V_s g^{\lambda s}}{Norm^3} V_k \dot{V}_\nu g^{k\nu} = \frac{\dot{V}_\lambda V_k g^{\lambda k}}{Norm} - \frac{V_k \dot{V}_\nu g^{k\nu}}{Norm} = 0 \qquad \textbf{(13)}$$

Thus

$$Curv^2 = W_\lambda W^\lambda = \frac{\dot{V}_\lambda \dot{V}_\nu g^{\lambda\nu}}{Norm^2} - \frac{V_\lambda \dot{V}_s g^{\lambda s}}{Norm^4} V_k \dot{V}_\nu g^{k\nu} = \frac{\dot{V}_\lambda \dot{V}^\lambda}{Norm^2} - \left(\frac{V_\lambda \dot{V}^\lambda}{Norm^2}\right)^2 \qquad \textbf{(14)}$$

Since $\frac{V_\lambda}{Norm}$ is the derivative of the normalized curve or normalized “speed”, using the upper Christoffel symbols, $\frac{d}{dt} V_\lambda = \left(\frac{d}{dx^r} V_\lambda - V_s \Gamma^s_{\lambda r}\right) \frac{dx^r}{dt} = (V_\lambda ;_r) \frac{V^r}{Norm}$ such that x^r denotes the local coordinates. If V_λ is a conserving field then $V_\lambda ;_r = V_r ;_\lambda$ and thus $V_\lambda ,_r V^r = \frac{1}{2} Norm^2 ,_\lambda$ and

$$Curv^2 = \frac{\dot{V}_\lambda \dot{V}^\lambda}{Norm^2} - \left(\frac{V_\lambda \dot{V}^\lambda}{Norm^2}\right)^2 = \frac{1}{4}\left(\frac{Norm^2,_\lambda Norm^2,_k g^{\lambda k}}{Norm^4} - \left(\frac{Norm^2,_s V_r g^{sr}}{Norm^3}\right)^2\right) \qquad \textbf{(15)}$$

Writing the last term in Riemannian geometry is the same field curvature operator that we chose on a conserving vector field.

11. Locally separable coordinates

The following is a bit speculative but may be important. It can't work globally because different upper limit time curves may intersect at single events. We see that 3 dimensions hint at 4 dimensional action. This is done by looking at the action (3) in three dimensions and observing the following way to write it,

$$\begin{pmatrix} \frac{(P^{\lambda}P_{\lambda}),_m P^m}{(P^iP_i)^{\frac{3}{2}}} & \frac{(P^{\lambda}P_{\lambda}),_0}{P^iP_i} & \frac{(P^{\lambda}P_{\lambda}),_1}{P^iP_i} & \frac{(P^{\lambda}P_{\lambda}),_2}{P^iP_i} \end{pmatrix} \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & g^{00} & g^{01} & g^{02} \\ 0 & g^{10} & g^{11} & g^{12} \\ 0 & g^{20} & g^{21} & g^{22} \end{pmatrix} \begin{pmatrix} \frac{(P^{\lambda}P_{\lambda}),_m P^m}{(P^iP_i)^{\frac{3}{2}}} \\ \frac{(P^{\lambda}P_{\lambda}),_0}{P^iP_i} \\ \frac{(P^{\lambda}P_{\lambda}),_1}{P^iP_i} \\ \frac{(P^{\lambda}P_{\lambda}),_2}{P^iP_i} \end{pmatrix}$$

$$g^{\mu\nu} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & g^{00} & g^{01} & g^{02} \\ 0 & g^{10} & g^{11} & g^{12} \\ 0 & g^{20} & g^{21} & g^{22} \end{pmatrix} \text{and } q^{ij} = \begin{pmatrix} g^{00} & g^{01} & g^{02} \\ g^{10} & g^{11} & g^{12} \\ g^{20} & g^{21} & g^{22} \end{pmatrix}$$

(16)

Where $g^{\mu\nu}$ is the metric tensor in 4 dimensions and q^{ij} is in 3. q^{ij} implicitly refers to a local submersion [16] where time is locally held constant.

Can we do the opposite, look at 4 dimensions and reduce the problem to 3 without violating the principle of covariance ?

First, our maximum proper time curves are intrinsic and do not depend on the coordinates. We can therefore agree that the absolute maximum proper time curves are different than ordinary geodesic curves on which only local maxima of proper time can be measured. We choose to describe (3) on our space-time in our special coordinates. Under correct choice of coordinates, the direction in space time of the maximum proper time is an eigenvector of the metric tensor with the biggest eigenvalue, our metric tensor is of the form presented in (16) for which the mixed space time terms are zero. Also,

$$P = \tau \Rightarrow P_0 = 1 \Rightarrow P_{\mu}P^{\mu} = -1 + P_{\lambda}P^{\lambda}, \lambda = 1,2,3 \text{ and}$$

$$P_0,_1 = P_0,_2 = P_0,_3 = P_1,_0 = P_2,_0 = P_3,_0 = 0$$

We can assume as possible $P_1 \neq 0, P_2 \neq 0, P_3 \neq 0$ especially if multiple maximum proper time curves to the same event 'e' exist. So instead of (3) we reduce the action to become three dimensional,

$$\text{Tweaked } \mathit{SquareCurvature} \equiv \frac{1}{4}\left(\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}(\mathrm{P}^{s}\mathrm{P}_{s}),_{\mathrm{k}}\, g^{mk}}{(-1+\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^{2}} - \frac{((\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}\mathrm{P}^{m})^{2}}{(-1+\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^{3}}\right)\sqrt{g}$$

or

$$\text{Tweaked } BE \equiv \frac{1}{4}\left(\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}(\mathrm{P}^{s}\mathrm{P}_{s}),_{\mathrm{k}}\, g^{mk}}{(-1+\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})} - \left(\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}\mathrm{P}^{m}}{(-1+\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})}\right)^{2}\right)\sqrt{g} = \tag{17}$$

$$(-1+\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})\cdot \mathit{SquareCurvature}$$

This means that on our three dimensional sub-manifolds ("Leaves of a foliation"), there is a corresponding action operator that is free of derivative dependence on time. Solving the Euler Lagrange equations for the Tweaked Square Curvature and receiving a plurality of solutions is indeed a promising direction of research.

12. Unsynchronizability

Since P is not constant on the 3 dimensional sub-manifolds perpendicular to the upper-limit-of-measurable-time-from-near-big-bang curves, these manifolds are not synchronizable and are therefore not the ideal inflating S(3) i.e. Friedmann – Robertson - Walker.

13. History of the paper's concept of time

The idea of an unreachable time, such as maximum proper time from a common event or set of events from which we can say the cosmos had started, i.e. "big bang", is not new [17], [18] and it appears in Hebrew writing such as the Book of Principles by the philosopher Rabbi Josef Albo 1380-1444. Rabbi Josef Albo wrote about time that can be measured by devices and another aspect of time which he termed immeasurable which he considered as an absolute inaccessible time because it does not depend on subjective measurement. The maximum proper time can't be measured by any massive devices because due to General Relativity, clock ticks are slowed down by the gravitational field of any mass.

14. Conservation of known matter from the Euler Lagrange Equations

Finally we get the following zero divergence:

$$\frac{d}{dx^{\mu}}\left(\frac{\partial L}{\partial P_{\mu}} - \frac{d}{dx^{\nu}}\frac{\partial L}{\partial P_{\mu},_{\nu}}\right)(U_k U^k \sqrt{-g}) = W^{\mu};_{\mu}\sqrt{-g} = 0 \quad \text{where}$$

W^{μ} is obtained from the subtraction of (35) from (36), see Appendix A.

Variation by P_{μ} and its derivatives is a special case

$$\left(\frac{\partial L}{\partial P_{\mu}} - \frac{d}{dx^{\nu}}\frac{\partial L}{\partial P_{\mu},_{\nu}}\right)(U_k U^k \sqrt{-g}) = 0\,.$$

$$\begin{aligned}
&(-4(\frac{Z^{\nu}}{Z^2});_{\nu} - 4\frac{Z_{\mathrm{m}}Z^{m}}{Z^3})\mathrm{P}^{\mu} + 4(\frac{(Z_s P^s)P^{\nu}}{Z^3});_{\nu} P^{\mu} \\
&- 2\frac{Z_{\mathrm{m}}P^{m}Z^{\mu}}{Z^3} + 6\frac{(Z_m P^m)^2}{Z^4}P^{\mu} = \\
&- 4(\frac{Z^{\nu}}{Z^2});_{\nu}\mathrm{P}^{\mu} - 4\frac{Z_{\mathrm{m}}Z^{m}}{Z^3}\mathrm{P}^{\mu} + \\
&+ 4(\frac{(Z_s P^s)P^{\nu}}{Z^3});_{\nu} P^{\mu} + 4\frac{(Z_m P^m)^2}{Z^4}P^{\mu} \qquad\qquad \mathbf{(18)} \\
&- 2\frac{Z_{\mathrm{m}}P^{m}}{Z^2}(\frac{Z^{\mu}}{Z} - \frac{Z_m P^m P^{\mu}}{Z^2}) = \\
&- 4((\frac{U^k}{Z});_k + \frac{U^k U_k}{Z})P^{\mu} - 2\frac{Z_{\mathrm{m}}P^{m}}{Z^2}U^{\mu} = 0
\end{aligned}$$

Recall that $U^k P_k = 0$, multiplication by $\frac{-P_{\mu}}{4}$ and contraction yields,

$$((\frac{Z^{\nu}}{Z^2});_{\nu} - (\frac{(Z_s P^s)P^{\nu}}{Z^3});_{\nu})Z + \frac{Z_{\mathrm{m}}Z^{m}}{Z^2} - \frac{(Z_m P^m)^2}{Z^3} = 0 \qquad \mathbf{(19)}$$

$$(\frac{Z^{\nu}}{Z^2});_{\nu} - (\frac{(Z_s P^s)P^{\nu}}{Z^3});_{\nu} + \frac{1}{Z}(\frac{Z_{\mathrm{m}}Z^{m}}{Z^2} - \frac{(Z_m P^m)^2}{Z^3}) = 0 \qquad \mathbf{(20)}$$

and as a result of (20) the following term from (7) vanishes,

$$
\begin{aligned}
&-2(U^k);_k \frac{P^\mu P^\nu}{Z} = -2(\frac{U^k}{Z});_k P^\mu P^\nu - 2U^k U_k \frac{P^\mu P^\nu}{Z} = \\
&-2(\frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_{\mathrm{m}} P^m}{Z^3} P^k);_k P^\mu P^\nu - 2\frac{(Z_{\mathrm{s}} P^s)^2}{Z^3}\frac{P^\mu P^\nu}{Z} + \\
&2(\frac{Z^m}{Z^2});_m P^\mu P^\nu + 2\frac{Z^\lambda Z_\lambda}{Z^2}\frac{P^\mu P^\nu}{Z} = \\
&-2(\frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_{\mathrm{m}} P^m}{Z^3} P^k);_k P^\mu P^\nu - 2\frac{(Z_{\mathrm{s}} P^s)^2}{Z^3}\frac{P^\mu P^\nu}{Z} + \\
&2(\frac{Z^m}{Z^2});_m P^\mu P^\nu + 2\frac{Z^\lambda Z_\lambda}{Z^2}\frac{P^\mu P^\nu}{Z} = \\
&2\left((\frac{Z^m}{Z^2});_m - (\frac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_{\mathrm{m}} P^m}{Z^3} P^k);_k + \frac{1}{Z}(\frac{Z^\lambda Z_\lambda}{Z^2} - \frac{(Z_{\mathrm{s}} P^s)^2}{Z^3})\right) P^\mu P^\nu = 0
\end{aligned}
\qquad \textbf{(21)}
$$

Which yields a simpler equation (9). Recall that $U^\nu = \frac{Z^\nu}{Z} - \frac{(Z_s P^s) P^\nu}{Z^2}$,

And that $\frac{Z_\nu}{Z} U^\nu = U_\nu U^\nu$

$$
\begin{aligned}
&(\frac{Z^\nu}{Z^2});_\nu - (\frac{(Z_s P^s) P^\nu}{Z^3});_\nu + \frac{1}{Z}(\frac{Z_{\mathrm{m}} Z^m}{Z^2} - \frac{(Z_m P^m)^2}{Z^3}) = \\
&(\frac{U^\nu}{Z});_\nu + \frac{1}{Z}(U_{\mathrm{m}} U^m) = \frac{1}{Z}(U^\nu);_\nu - \frac{1}{Z^2} U^\nu Z_\nu + \frac{1}{Z}(U_{\mathrm{m}} U^m) = \\
&\frac{1}{Z}(U^\nu);_\nu = 0
\end{aligned}
\qquad \textbf{(22)}
$$

Which proves (8)

$$\boxed{(U^\nu);_\nu = 0} \qquad \textbf{(23, see 8)}$$

And proves the simple representation of the field equations

That we saw in (7)

$$\boxed{\frac{8\pi}{4}(U^\mu U^\nu - \frac{1}{2} U_k U^k g^{\mu\nu}) = R^{\mu\nu} - \frac{1}{2} R g^{\mu\nu}} \qquad \textbf{(24, see 9)}$$

15. Chameleon Fields or Pressure ?

As we can see, the more general case is,

$$W^{\mu};_{\mu}=\begin{pmatrix} 4(\frac{(Z_sP^s)P^\nu}{Z^3});_\nu P^\mu+4\frac{(Z_mP^m)^2}{Z^4}P^\mu+ \\ -4(\frac{Z^\nu}{Z^2});_\nu \mathrm{P}^\mu-4\frac{Z_\mathrm{m}Z^m}{Z^3}\mathrm{P}^\mu+ \\ 2\frac{(Z_mP^m)^2}{Z^4}P^\mu-2\frac{Z_\mathrm{m}P^mZ^\mu}{Z^3} \end{pmatrix};_\mu=0 \qquad \textbf{(25)}$$

$$\frac{d}{dx^\mu}(\frac{\partial L}{\partial P_\mu}-\frac{d}{dx^\nu}\frac{\partial L}{\partial P_{\mu},_\nu})(U_kU^k\sqrt{-g})=W^\mu;_\mu\sqrt{-g}=0 \qquad \textbf{(26)}$$

instead of

$$(\frac{\partial L}{\partial P_\mu}-\frac{d}{dx^\nu}\frac{\partial L}{\partial P_{\mu},_\nu})(U_kU^k\sqrt{-g})=0 \qquad \textbf{(27)}$$

An effect which is contrary to gravity will add a positive delta to the Ricci curvature and therefore from (7), multiplication by the metric tensor $g_{\mu\nu}$ and contraction yields,

$$+2(\frac{(\mathrm{P}^\lambda\mathrm{P}_\lambda),_\mathrm{m}P^m}{Z^3}P^k);_kZ+2\frac{(Z_\mathrm{s}P^s)^2}{Z^3}-2(\frac{Z^m}{Z^2});_mZ-2\frac{Z^\lambda Z_\lambda}{Z^2}<0 \qquad \textbf{(28)}$$

An effect which adds gravity, will add negative delta to Ricci curvature and therefore,

$$+2(\frac{(\mathrm{P}^\lambda\mathrm{P}_\lambda),_\mathrm{m}P^m}{Z^3}P^k);_kZ+2\frac{(Z_\mathrm{s}P^s)^2}{Z^3}-2(\frac{Z^m}{Z^2});_mZ-2\frac{Z^\lambda Z_\lambda}{Z^2}>0 \qquad \textbf{(29)}$$

Known matter will be simpler

$$+2(\frac{(\mathrm{P}^\lambda\mathrm{P}_\lambda),_\mathrm{m}P^m}{Z^3}P^k);_kZ+2\frac{(Z_\mathrm{s}P^s)^2}{Z^3}-2(\frac{Z^m}{Z^2});_mZ-2\frac{Z^\lambda Z_\lambda}{Z^2}=0 \qquad \textbf{(30)}$$

It is possible that either (28) or (29) is mathematically not valid. Additional terms can't violate the vanishing of the divergence of Einstein tensor. High order derivatives of the metric tensor and pressure were studied by Deser and Tekin [19]. For application of (28) and/or (29) to space-time warp drive please refer to [20].

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17. Conclusions – test for the theory

General

Maximal time from an event back to near "big bang" event or events, is measured by particle clocks. This time sets an upper limit on measurable time quite similar to the way the speed of light sets an upper limit on speed. Physics, however is local and therefore only the gradient of this upper limit has a true physical meaning.

Since time is measured by material clocks, these material clocks are influenced by forces. The particle that can measure the maximal possible time from the “big bang” event or events to an event within matter will therefore be influenced by such forces along with the influence of its own gravitational field. Non geodesic motion as uniform acceleration is well defined by Friedman-Scarr representation (although the author does not agree with all of their claims) and has a linear interpretation by an anti-symmetric tensor [21] which also indirectly describes an intuitive relation to spinors (well at least if we can blissfully afford to ignore wave functions, and group representation, see Appendix C), however, the most interesting effects that this theory offers, are beyond the scope of Friedman-Scarr representation of acceleration $A_{\mu\nu}W^{\nu} = a_{\mu}$, speed $W_{\mu}W^{\mu} = 1$ and acceleration matrix $A_{\mu\nu} = -A_{\nu\mu}$.

As a down-to-earth summary, the proof of this theory will start by experimental evidence that there is a lower limit of acceleration $\frac{1}{C^4}\frac{du^i}{d\tau}\frac{du_i}{d\tau}$ as a particle interacts with a constant material force field. This will show that the idea of event that is discussed in this paper has a physical meaning. There is experimental evidence regarding high gradient of an electric field in which force that acts on metal balls is

represented as the ordinary force on the induced dipole as in ordinary dielectrophoresis [10] plus an unexpected "force" that depends on mass [11]. [11] can attest to the existence of true force field, which is not gravity, that depends on mass, as also seems to be an outcome of this theory. This is one way to achieve a unique trajectory of the maximally measured proper time by any massive test particle including zero mass Chronons [2] which are perfect theoretical clocks. In this case, [11] can be an exposure of a fundamental field, more basic than the electro-magnetic forces and it can be expressed in the non relativistic classical limit as $\sqrt{\frac{K\varepsilon_0}{2}}Em_0 \approx F - F_{DEP}$. Even in a homogenous static electric field we would expect a very weak acceleration field, $1.71888777 * 10^{-11}\,\mathrm{Metre}^2 * \mathrm{Volt}^{-1} * \mathrm{Second}^{-2}$. It takes 1000000 Volts over a gap of 1mm to expose an acceleration field of 1.71888777 cm/sec^2 which depends on mass and yet is not the signature of gravity.

Speculative conclusions

Another effect is that (28) and (29) allow gravity to be generated from non linear force fields. If the 4-force is not linear then (28) or (29) are possible which allow warps or gravitational dipoles [20]. In order for such an effect to be consistent with the vanishing divergence of Einstein tensor and with conservation laws, (28) and (29) mean the creation of gravitational dipoles. The overall momentum – energy must be preserved. In this case, the simple equation (7) can't be reduced to (9).

18. Appendix A: The Euler Lagrange Equations of the SquareCurvature action

We will not solve the entire system

$$\boxed{\begin{aligned} &Z = P_\mu P^\mu \ and\ U_\lambda = \frac{Z_\lambda}{Z} - \frac{Z_k P^k P_\lambda}{Z^2}\ and\ L = \frac{1}{4}U^k U_k \\ &R = Ricci\ curvature. \\ &\delta\int_\Omega \left(\frac{1}{2}R - \frac{8\pi}{4}U^k U_k\right)\cdot\sqrt{-g}\,d\Omega = 0 \end{aligned}} \qquad \textbf{(31)}$$

But rather focus on $\int_\Omega U^k U_k \sqrt{-g}\, d\Omega$

$$
\boxed{
\begin{array}{l}
L = \dfrac{(P^\lambda Z_\lambda)^2}{Z^3} \ \ s.t.\ Z = P_\mu P^\mu \\
\dfrac{\partial(L\sqrt{-g})}{\partial g^{\mu\nu}} - \dfrac{d}{dx^m}\dfrac{\partial(L\sqrt{-g})}{\partial(g^{\mu\nu},_m)} = \\
\left(\begin{array}{l}
-2(\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3} P_\mu P_\nu P^m);_m - 2\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3}(\Gamma_\mu{}^i{}_m P_i P_\nu P^m + \Gamma_\upsilon{}^i{}_m P_\mu P_i P^m) + \\
+2(\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3} P_\mu P_\nu);_m P^m + 2\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3}(\Gamma_\mu{}^i{}_m P_i P_\nu P^m + \Gamma_\upsilon{}^i{}_m P_\mu P_i P^m) + \\
+2(\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3})Z_\mu P_\nu - 3(\dfrac{((P^\lambda P_\lambda),_s P^s)^2}{Z^4})P_\mu P_\nu - \dfrac{1}{2}\dfrac{(P^\lambda Z_\lambda)^2}{Z^3} g_{\mu\nu}
\end{array}\right)\sqrt{-g} \\
= \left(\begin{array}{l}
-2(\dfrac{(P^\lambda P_\lambda),_m P^m}{Z^3} P^k);_k P_\mu P_\nu - 2\dfrac{(P^\lambda Z_\lambda)^2}{Z^3}\dfrac{P_\mu P_\nu}{Z} + 2(\dfrac{(P^\lambda P_\lambda),_s P^s}{Z^3})Z_\mu P_\nu + \\
-\dfrac{1}{2}\dfrac{(P^\lambda Z_\lambda)^2}{Z^3} g_{\mu\nu} - \dfrac{(P^\lambda Z_\lambda)^2}{Z^3}\dfrac{P_\mu P_\nu}{Z}
\end{array}\right)\sqrt{-g}
\end{array}
}
$$

(32)

$$
\boxed{
\begin{array}{l}
L = \dfrac{Z^\lambda Z_\lambda}{Z^2} \ \ s.t.\ Z = P_\mu P^\mu \\
\dfrac{\partial(L\sqrt{-g})}{\partial g^{\mu\upsilon}} - \dfrac{d}{dx^m}\dfrac{\partial(L\sqrt{-g})}{\partial g^{\mu\upsilon},_m} = \\
\left(\begin{array}{l}
-2(\dfrac{Z^m P_\mu P_\upsilon}{Z^2});_m - 2\dfrac{(\Gamma_\mu{}^i{}_m P_i P_\nu Z^m + \Gamma_\upsilon{}^i{}_m P_\mu P_i Z^m)}{Z^2}) + \\
+2\dfrac{(P_\mu P_\upsilon);_m Z^m)}{Z^2} + 2\dfrac{(\Gamma_\mu{}^i{}_m P_i P_\nu Z^m + \Gamma_\upsilon{}^i{}_m P_\mu P_i Z^m)}{Z^2}) + \\
+\dfrac{Z_\mu Z_\nu}{Z^2} - 2\dfrac{Z_s Z^s}{Z^3} P_\mu P_\nu - \dfrac{1}{2}\dfrac{Z_m Z^m}{(P^i P_i)^2} g_{\mu\nu}
\end{array}\right)\sqrt{-g} = \\
(-2(\dfrac{Z^m}{Z^2});_m P_\mu P_\nu - 2\dfrac{Z^\lambda Z_\lambda}{Z^2}\dfrac{P_\mu P_\nu}{Z} - \dfrac{1}{2}\dfrac{Z_k Z^k}{Z^2} g_{\mu\nu} + \dfrac{Z_\mu Z_\nu}{Z^2})\sqrt{-g}
\end{array}
}
$$

(33)

$$Z = P_\mu P^\mu \ and\ U_\lambda = \frac{Z_\lambda}{Z} - \frac{Z_k P^k P_\lambda}{Z^2}\ and\ L = U^\kappa U_k$$

$$\frac{\partial(L\sqrt{-g}\,)}{\partial g^{\mu\upsilon}} - \frac{d}{dx^m}\frac{\partial(L\sqrt{-g}\,)}{\partial g^{\mu\upsilon},_m} =$$

$$\begin{pmatrix} +2(\frac{(P^\lambda P_\lambda),_m P^m}{Z^3}P^k);_k P_\mu P_\nu + 2\frac{(P^\lambda Z_\lambda)^2}{Z^3}\frac{P_\mu P_\nu}{Z} - 2(\frac{(P^\lambda P_\lambda),_s P^s}{Z^3})Z_\mu P_\nu + \\ +\frac{1}{2}\frac{(P^\lambda Z_\lambda)^2}{Z^3}g_{\mu\nu} + \frac{(P^\lambda Z_\lambda)^2}{Z^3}\frac{P_\mu P_\nu}{Z} + \\ (-2(\frac{Z^m}{Z^2});_m P_\mu P_\nu - 2\frac{Z^\lambda Z_\lambda}{Z^2}\frac{P_\mu P_\nu}{Z} - \frac{1}{2}\frac{Z_k Z^k}{Z^2}g_{\mu\nu} + \frac{Z_\mu Z_\nu}{Z^2}) \end{pmatrix} .\sqrt{-g} =$$

$$\begin{pmatrix} +2((\frac{(P^\lambda P_\lambda),_m P^m}{Z^3}P^k);_k - 2(\frac{Z^m}{Z^2});_m)P_\mu P_\nu + \\ +2\frac{(P^\lambda Z_\lambda)^2}{Z^3}\frac{P_\mu P_\nu}{Z} - 2\frac{Z^\lambda Z_\lambda}{Z^2}\frac{P_\mu P_\nu}{Z} + \\ +\frac{1}{2}\frac{(P^\lambda Z_\lambda)^2}{Z^3}g_{\mu\nu} - \frac{1}{2}\frac{Z_k Z^k}{Z^2}g_{\mu\nu} + \\ +\frac{Z_\mu Z_\nu}{Z^2} - 2(\frac{(P^\lambda P_\lambda),_s P^s}{Z^3})Z_\mu P_\nu + \frac{(P^\lambda Z_\lambda)^2}{Z^3}\frac{P_\mu P_\nu}{Z} \end{pmatrix} .\sqrt{-g} =$$

$$\begin{pmatrix} +2((\frac{(P^\lambda P_\lambda),_m P^m}{Z^3}P^k);_k - 2(\frac{Z^m}{Z^2});_m)P_\mu P_\nu + \\ +2\frac{(P^\lambda Z_\lambda)^2}{Z^3}\frac{P_\mu P_\nu}{Z} - 2\frac{Z^\lambda Z_\lambda}{Z^2}\frac{P_\mu P_\nu}{Z} + \\ +U_\mu U_\nu - \frac{1}{2}U_k U^k g_{\mu\nu} \end{pmatrix} .\sqrt{-g} =$$

$$(U_\mu U_\nu - \frac{1}{2}U_k U^k g_{\mu\nu} - U^k;_k \frac{P_\mu P_\nu}{Z})\sqrt{-g}$$

(34)

$$
\boxed{
\begin{array}{l}
L = \dfrac{(Z^s P_s)^2}{Z^3} \quad s.t.\ Z = P^\lambda P_\lambda \ and\ Z_m = (P^\lambda P_\lambda),_m \\
\dfrac{\partial(L\sqrt{-g})}{\partial P_\mu} - \dfrac{d}{dx^\nu}\dfrac{\partial(L\sqrt{-g})}{\partial P_\mu,_\nu} = \\
\left(
\begin{array}{l}
-4\dfrac{(Z_s P^s)}{Z^3}(P^\mu P^\nu);_\nu - 4\dfrac{(Z_s P^s)}{Z^3}\Gamma_i{}^\mu{}_\nu P^i P^\nu + \\
+4\dfrac{(Z_s P^s)}{Z^3}P^\mu;_\nu P^\nu + 4\dfrac{(Z_s P^s)}{Z^3}\Gamma_i{}^\mu{}_k P^i P^k + \\
+2\dfrac{Z_m P^m Z^\mu}{Z^3} - 6\dfrac{(Z_m P^m)^2}{Z^4}P^\mu
\end{array}
\right)\sqrt{-g} = \\
(-4(\dfrac{(Z_s P^s)P^\nu}{Z^3});_\nu P^\mu + 2\dfrac{Z_m P^m Z^\mu}{Z^3} - 6\dfrac{(Z_m P^m)^2}{Z^4}P^\mu)\sqrt{-g}
\end{array}
}
\tag{35}
$$

$$
\boxed{
\begin{array}{l}
L = \dfrac{Z^s Z_s}{Z^2} \quad s.t.\ Z = P^\lambda P_\lambda \ and\ Z_m = (P^\lambda P_\lambda),_m \\
\dfrac{\partial(L\sqrt{-g})}{\partial P_\mu} - \dfrac{d}{dx^\nu}\dfrac{\partial(L\sqrt{-g})}{\partial P_\mu,_\nu} = \\
\left(
\begin{array}{l}
-4(\dfrac{P^\mu Z^\nu}{Z^2});_\nu - \dfrac{4}{Z^2}\Gamma_i{}^\mu{}_k P^i Z^k + \\
+\dfrac{4}{Z^2}P^\mu;_\nu Z^\nu + \dfrac{4}{Z^2}\Gamma_i{}^\mu{}_k P^i Z^k + \\
-4\dfrac{Z_m Z^m}{Z^3}P^\mu\sqrt{-g}
\end{array}
\right)\sqrt{-g} = \\
(-4(\dfrac{Z^\nu}{Z^2});_\nu - 4\dfrac{Z_m Z^m}{Z^3})P^\mu\sqrt{-g}
\end{array}
}
\tag{36}
$$

19. Appendix B: The scalar time field of the Schwarzschild solution

We would like to calculate $\left(\dfrac{(P^\lambda P_\lambda),_m (P^s P_s),_k g^{mk}}{(P^i P_i)^2} - \dfrac{((P^\lambda P_\lambda),_m P^m)^2}{(P^i P_i)^3}\right)$ in Schwarzschild coordinates for a freely falling particle. This theory predicts that where there is no matter, the result must be zero. The result also must be zero along any geodesic curve but in the middle of a hollowed ball of mass the gradient of the absolute maximum proper time from "Big Bang" event or events, derivatives by space must be zero due to symmetry which means the curves come from different directions to the same event at the center. Close to the edges, gravitational lenses due to granularity of matter become crucial. The speed U of a falling particle as measured

by an observer in the gravitational field is

$$V^2 = \frac{U^2}{C^2} = \frac{R}{r} = \frac{2GM}{rC^2} \qquad \textbf{(37)}$$

Where R is the Schwarzschild radius. If speed V is normalized in relation to the speed of light then $V = \frac{U}{C}$. For a far observer, the deltas are denoted by dt', dr' and,

$$\dot{r}^2 = (\frac{dr}{dt})^2 = V^2(1-\frac{R}{r}) \qquad \textbf{(38)}$$

because $dr = dr'/\sqrt{1-R/r}$ and $dt = dt'\sqrt{1-R/r}$.

$$P = \int_0^t \sqrt{(1-\frac{R}{r}) - \frac{(dr/dt)^2}{(1-\frac{R}{r})}}dt = \int_0^t \sqrt{(1-\frac{R}{r}) - \frac{\frac{R}{r}(1-\frac{R}{r})^2}{(1-\frac{R}{r})}}dt = \int_0^t \sqrt{(1-\frac{R}{r})^2}dt =$$

$$\int_0^t (1-\frac{R}{r})dt$$

Which results in,

$$P_t = \frac{dP}{dt} = (1-\frac{R}{r}) \qquad \textbf{(39)}$$

Please note, here t is not a tensor index and it denotes derivative by t !!!

On the other hand

$$P = \int_\infty^r \sqrt{(1-\frac{R}{r})\frac{1}{\dot{r}^2} - \frac{1}{(1-\frac{R}{r})}}dr = \int_\infty^r \sqrt{\frac{(1-\frac{R}{r})\frac{r}{R}}{(1-\frac{R}{r})^2} - \frac{1}{(1-\frac{R}{r})}}dr = \int_\infty^r \sqrt{\frac{\frac{r-R}{R}}{\frac{r-R}{r}}}dr =$$

$$\int_\infty^r \sqrt{\frac{r}{R}}dr$$

Which results in

$$P_r = \frac{dP}{dr} = \sqrt{\frac{r}{R}} \qquad \textbf{(40)}$$

Please note, here r is not a tensor index and it denotes derivative by r !!!

For the square norms of derivatives we use the inverse of the metric tensor,

So we have $(1-\frac{R}{r}) \to \frac{1}{(1-\frac{R}{r})}$ and $\frac{1}{(1-\frac{R}{r})} \to (1-\frac{R}{r})$

So we can write

$$N^2 = P^\lambda P_\lambda = (1-\frac{R}{r})P_r{}^2 - \frac{1}{1-\frac{R}{r}}P_t{}^2 = (1-\frac{R}{r})(\frac{r}{R}-1) = \frac{r}{R}+\frac{R}{r}-2$$

$$N^2 = \frac{r}{R}+\frac{R}{r}-2 \qquad \textbf{(41)}$$

$N^2{}_\lambda = \dfrac{dN^2}{dx^\lambda}$ And we can calculate

$$\frac{N^2{}_\lambda N^{2\lambda}}{(N^2)^2} = \frac{(1-\frac{R}{r})^2(\frac{1}{R}-\frac{R}{r^2})^2}{(\frac{r}{R}+\frac{R}{r}-2)^2} \qquad \textbf{(42)}$$

We continue to calculate

$N^2{}_t P_t = (1-\dfrac{R}{r})^2(\dfrac{1}{R}-\dfrac{R}{r^2})\sqrt{\dfrac{R}{r}}$ and

$$\frac{N^2{}_t P_t}{(1-\frac{R}{r})} = (1-\frac{R}{r})(\frac{1}{R}-\frac{R}{r^2})\sqrt{\frac{R}{r}} \qquad \textbf{(43)}$$

Please note, here t is not a tensor index and it denotes derivative by t !!!

$$(1-\frac{R}{r})N^2{}_r P_r = (1-\frac{R}{r})(\frac{1}{R}-\frac{R}{r^2})\sqrt{\frac{r}{R}} \qquad \textbf{(44)}$$

Please note, here r is not a tensor index and it denotes derivative by r !!!

$N^2{}_\lambda P^\lambda = (1-\dfrac{R}{r})(\dfrac{1}{R}-\dfrac{R}{r^2})(\sqrt{\dfrac{r}{R}}-\sqrt{\dfrac{R}{r}})$ And

$$(N^2{}_\lambda P^\lambda)^2 = (1-\frac{R}{r})^2(\frac{1}{R}-\frac{R}{r^2})^2(\frac{r}{R}+\frac{R}{r}-2) \qquad \textbf{(45)}$$

So

$$\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3} = \frac{(1-\frac{R}{r})^2(\frac{1}{R}-\frac{R}{r^2})^2}{(\frac{r}{R}+\frac{R}{r}-2)^2} \qquad \textbf{(46)}$$

And finally, from (42) and (46) we have,

$$\left(\frac{(\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}(\mathrm{P}^{s}\mathrm{P}_{s}),_{\mathrm{k}}\, g^{mk}}{(\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^{2}}-\frac{((\mathrm{P}^{\lambda}\mathrm{P}_{\lambda}),_{\mathrm{m}}\mathrm{P}^{m})^{2}}{(\mathrm{P}^{\mathrm{i}}\mathrm{P}_{\mathrm{i}})^{3}}\right)=$$

$$\frac{N^{2}{}_{\lambda}N^{2\lambda}}{(N^{2})^{2}}-\frac{(N^{2}{}_{\lambda}P^{\lambda})^{2}}{(N^{2})^{3}}= \qquad \textbf{(47)}$$

$$\frac{(1-\frac{R}{r})^{2}(\frac{1}{R}-\frac{R}{r^{2}})^{2}}{(\frac{r}{R}+\frac{R}{r}-2)^{2}}-\frac{(1-\frac{R}{r})^{2}(\frac{1}{R}-\frac{R}{r^{2}})^{2}}{(\frac{r}{R}+\frac{R}{r}-2)^{2}}=0$$

which shows that indeed the gradient of time measured, by a falling particle until it hits an event in the gravitational field, has zero curvature as expected.

The term $N^{2}=\frac{r}{R}+\frac{R}{r}-2$ is slightly disturbing because at very far distances, $\frac{r}{R}$ becomes significant. Moreover, if R has a lower atomic limit, then for such R the term $\frac{r}{R}$ is a whole number! We now return to the discussion about a hollowed ball of mass. It is clear that the maximum proper time from "Big Bang" - event or events - curves entering the ball are symmetrical in relation to the center and therefore $P_{r}(0)=0=\frac{dP}{dr}\neq\sqrt{\frac{r_{0}}{R}}$ where r_{0} is the radius in the far coordinate system of the hollowed ball of mass. However, $P_{t}=\frac{dP}{dt}=(1-\frac{R}{r_{0}})$. Writing the gradient in two dimensions in t, r, ignoring the gravitational lenses due to mass granularity, and ignoring quantum uncertainties of coordinates and of energy momentum, we have

$$(P_{t},P_{r})=\left\{\begin{array}{c} r>r_{0}\Rightarrow((1-\frac{R}{r}),\sqrt{\frac{r}{R}}) \\ \\ 0<r<r0\Rightarrow((1-\frac{R}{r_{0}}),\sqrt{\frac{r_{0}}{R}})??? \\ \\ r=0\Rightarrow((1-\frac{R}{r_{0}}),0)??? \end{array}\right\} \qquad \textbf{(48)}$$

The last result $P_{r}(0)=0=\frac{dP}{dr}\neq\sqrt{\frac{r_{0}}{R}}$ is an inevitable outcome of the symmetry in the

center of the ball. The gradient by the space coordinates must be zero and the change of direction in the gradient means that curvature is inevitable.

Center analysis if there is an atom of translation length

Without even negligible forces acting on a test particle and without quantum center location uncertainty, in the middle of a hollowed ball of mass the gradient of absolute maximal proper time is discontinuous due to symmetry. Suppose that the difference between the gradient at the center where $r = 0$ and where, $r = \delta r$, such that δr is small, results in $\delta N^2(0)$. We want to measure the second power of the curvature of the gradient of absolute maximum proper time due to that difference. Suppose that the change happens smoothly within a small radius from the center, measured around $r = 0$. We assume that such curvature measures how much the gradient is not geodesic due to curve intersections. Consider $g^{3,3} = (1 - \frac{R}{r_0})$ and $g^{0,0} = 1/(1 - \frac{R}{r_0})$

$$(P_t(0), P_r(0)) = ((1 - \frac{R}{r_0}), 0) \qquad \textbf{(49)}$$

$$(P_t(\delta r'), P_r(\delta r')) = ((1 - \frac{R}{r_0}), \sqrt{\frac{r_0}{R}}) \qquad \textbf{(50)}$$

$$\delta N^2(0) = \frac{(1 - \frac{R}{r_0})^2}{(1 - \frac{R}{r_0})} - ((\frac{(1 - \frac{R}{r_0})^2}{(1 - \frac{R}{r_0})} - \frac{r_0}{R}(1 - \frac{R}{r_0})) = \frac{r_0}{R} - 1 \qquad \textbf{(51)}$$

$$\frac{\delta N^2(0)}{\delta r} g^{3,3} = \frac{\delta N^2(0)}{\delta r' \sqrt{1 - \frac{R}{r_0}}} g^{3,3} =$$

$$\frac{\frac{r_0}{R} - 1}{\delta r' \sqrt{1 - \frac{R}{r_0}}}(1 - \frac{R}{r_0}) = (\frac{r_0}{R} - 1)\sqrt{1 - \frac{R}{r_0}} \qquad \textbf{(52)}$$

$$\frac{\delta N^2(0)}{\delta t} g^{0,0} = \frac{\delta N^2(0)\sqrt{1-\frac{R}{r_0}}}{\delta t'} g^{3,3} = \frac{\delta N^2(0)\sqrt{1-\frac{R}{r_0}}}{\delta r'\sqrt{\frac{r_0}{R}}} g^{3,3} =$$

(53)

$$\frac{\delta N^2(0)}{\delta r'\sqrt{1-\frac{R}{r_0}}\sqrt{\frac{r_0}{R}}} = \frac{\frac{r_0}{R}-1}{\delta r'\sqrt{1-\frac{R}{r_0}}\sqrt{\frac{r_0}{R}}}$$

$$N^2{}_\lambda N^{2\lambda} = \frac{(\frac{r_0}{R}-1)^2}{(\delta r')^2\frac{r_0}{R}} - \frac{(\frac{r_0}{R}-1)^2}{(\delta r')^2} = -\frac{(\frac{r_0}{R}-1)^2}{(\delta r')^2}(1-\frac{R}{r_0}) \qquad \textbf{(54)}$$

$$\frac{N^2{}_\lambda N^{2\lambda}}{(N^2)^2} = -\frac{(\frac{r_0}{R}-1)^2(1-\frac{R}{r_0})}{(\delta r')^2(\frac{r_0}{R}+\frac{R}{r_0}-2)^2} \qquad \textbf{(55)}$$

$$\frac{\delta N^2(0)}{\delta t} g^{0,0} P_t = \frac{(\frac{r_0}{R}-1)\sqrt{\frac{R}{r_0}}\sqrt{1-\frac{R}{r_0}}}{\delta r'} \qquad \textbf{(56)}$$

$$\frac{\delta N^2(0)}{\delta r} g^{3,3} P_r = \frac{(\frac{r_0}{R}-1)\sqrt{\frac{r_0}{R}}\sqrt{1-\frac{R}{r_0}}}{\delta r'} \qquad \textbf{(57)}$$

$$N^2{}_\lambda P^\lambda = \frac{(\frac{r_0}{R}-1)\sqrt{1-\frac{R}{r_0}}}{\delta r'}\left(\sqrt{\frac{R}{r_0}}-\sqrt{\frac{r_0}{R}}\right) \qquad \textbf{(58)}$$

$$(N^2{}_\lambda P^\lambda)^2 = \frac{(\frac{r_0}{R}-1)^2(1-\frac{R}{r_0})}{(\delta r')^2}\left(\frac{r_0}{R}+\frac{R}{r_0}-2\right) \qquad \textbf{(59)}$$

$$\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3} = \frac{\frac{(\frac{r_0}{R}-1)^2(1-\frac{R}{r_0})}{(\delta r')^2}(\frac{r_0}{R}+\frac{R}{r_0}-2)}{(\frac{r_0}{R}+\frac{R}{r_0}-2)^3} =$$

(60)

$$\frac{(\frac{r_0}{R}-1)^2(1-\frac{R}{r_0})}{(\delta r')^2(\frac{r_0}{R}+\frac{R}{r_0}-2)^2}$$

$$\frac{N^2{}_\lambda N^{2^\lambda}}{(N^2)^2}-\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3}=-2\frac{(\frac{r_0}{R}-1)^2(1-\frac{R}{r_0})}{(\delta r')^2(\frac{r_0}{R}+\frac{R}{r_0}-2)^2} \quad \textbf{(61)}$$

$$\frac{N^2{}_\lambda N^{2^\lambda}}{(N^2)^2}-\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3}=-2\frac{(\frac{r_0-R}{R})^2(\frac{r_0-R}{r_0})}{(\delta r')^2(\frac{(r_0-R)^2}{r_0R})^2}= \quad \textbf{(62)}$$

$$\frac{-2r_0}{(\delta r')^2(r_0-R)}=\frac{-2}{(\delta r')^2(1-\frac{R}{r_0})}$$

Given the radius $\delta r'$ that is seen within the gravitational field, the surface of a small ball around the center is smaller than expected in flat space-time,

$$Vol'=\frac{4\pi}{3}(\delta r')^3(1-\frac{R}{r_0}) \quad \textbf{(63)}$$

We now calculate the curvature and then multiply it by the volume of the ball in which the direction of the gradient changes towards the center as seen in (49),(50),

$$SquareCurvature=\frac{1}{4}(\frac{N\ {}_\lambda N^{2^\lambda}}{(N^2)^2}-\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3})\sqrt{-g}$$

$$\frac{1}{4}(\frac{N^2{}_\lambda N^{2^\lambda}}{(N^2)^2}-\frac{(N^2{}_\lambda P^\lambda)^2}{(N^2)^3})Vol'=\frac{4\pi}{3}(\delta r')^3(\frac{r_0-R}{r_0})\frac{1}{4}\frac{-2r_0}{(\delta r')^2(r_0-R)}=\frac{-2\pi}{3}\delta r' \quad \textbf{(64)}$$

(64) is very interesting because it depends only on $\delta r'$ and not on the mass of the gravitational source.

20. Appendix B2: Approximated validity test at the Planck scale

(64) imposes some strict limits on the offered theory. For the following, we assume that $\delta r=\delta r'(\sqrt{1-R/\delta r}$ is big enough in comparison to the Schwarzschild radius R otherwise none of the following calculations will be valid. Suppose that all the matter we have is due to force field acting along the distance $\delta r'$. Then by (9) and the following conclusion that $-L=-R$ and by Einstein equation of Gravity

$\frac{8\pi K}{c^4}T_{\mu\nu} = G_{\mu\nu}$, and from (64) we have the following,

$$\frac{-(8\pi)2\pi}{3}\delta r' = -\frac{8\pi K}{c^4}\delta E \qquad \textbf{(65)}$$

Where δE is achieved via integration of energy on space. K is the known Gravity constant $K = 6.67384(80)*10^{-11}m^3kg^{-1}s^{-2}$ and $c = 2.99792458*10^8 m^1s^{-1}$.

So we can divide the equation by $\delta r'$

So we have $\frac{2\pi c^4}{3K} = \frac{\delta E}{\delta r'} = Force$ **(66)**

That is quite a strong force, about $2.5349249979452157571914167314415*10^{44}$ Newtons. On the other hand if our energy is within a ball of radius $\delta r'$ and $\delta r'$ is also the uncertainty of the space coordinate of the center then we have by the law of uncertainty of Quantum Mechanics

$$\delta P\delta r' \geq \frac{\hbar}{2} \qquad \textbf{(67)}$$

$\hbar \cong 1.05457172647*10^{34} J\cdot s$ and in the inequality extremity of equality,

$$\delta P\delta r' = \frac{\hbar}{2} \qquad \textbf{(68)}$$

Now consider (66) which is a very strong force, acting on a small enough particle so virtually we can say that the speed of the particle is approximated by an average speed which the speed of light. So

$$c\delta P\delta r' \cong \delta E \Rightarrow \delta r' = \frac{3K}{2\pi c^3}\delta P = \frac{3K\hbar}{4\pi c^3\delta r'} \Rightarrow \delta r' = \sqrt{\frac{3K\hbar}{4\pi c^3}} \qquad \textbf{(69)}$$

Recall the definition of work as Force multiplied by length on which the force acted, we have from (69) and from (66)

$$Force * \delta r' \cong \frac{2\pi c^4}{3K}\sqrt{\frac{3K\hbar}{4\pi c^3}} = \sqrt{\frac{\pi\hbar c^5}{3K}} \qquad \textbf{(70)}$$

This value is quite close to the Planck Energy $\sqrt{\frac{\hbar c^5}{K}}$.

21. Appendix C: Ashtekar variables in the description of a non-gravitational acceleration field

We would like to extract a general force from the relation between U_μ and P_λ.

This work is related to both Sam Vaknin's work from 1982 [2] and to Fridman - Scarr force representation [21]. Please note that the theory is of a non-gravitational acceleration that causes space-time curvature rather than force theory.

The curvature vector is $U_\mu = \dfrac{P_\mu;_i P*^i}{\sqrt{(P_k P*^k)(P*_L P^L)}} - \dfrac{P_k;_i P*^i P*^k P_\mu}{(P_k P*^k)(P*_L P^L)}$ or

$U_m = \dfrac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mathrm{m}}{\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i}} - \dfrac{(\mathrm{P}^\lambda \mathrm{P}_\lambda),_\mu \mathrm{P}^\mu}{(\mathrm{P}^\mathrm{i}\mathrm{P}_\mathrm{i})^2} P_m$. Obviously $U_\mu P*^\mu = 0$.

It measures how a trajectory of a particle measuring the gradient of upper limit of measurable time $P_k = \dfrac{dP}{dx^k} = \dfrac{d\tau}{dx^k}$, (or coped with probability function $P_k = \dfrac{d(\tau\psi)}{dx^k}$), is not geodesic. We now want to link P_k and U_μ to force in order to predict force on any test particle (with some conditions on its direction). By the principle of parsimony we would like to find a matrix $A_{k\mu} = -A_{\mu k}$ such that

$$A_{\mu k} \frac{P*^k}{\sqrt{\sqrt{(P_k P*^k)(P*_L P^L)}}} = U*_\mu \qquad \textbf{(71)}$$

The simplest representation needs only three complex variables, a,b,c

$$A_{\mu k} = \begin{pmatrix} 0 & a & -b & -c \\ -a & 0 & c & -b \\ b & -c & 0 & -a \\ c & b & a & 0 \end{pmatrix} \qquad \textbf{(72)}$$

Please note that the matrix is orthogonal in the Euclidean sense and that the following is Unitary in the Euclidean sense,

$$U_{\mu k} = \frac{1}{\sqrt{a^2+b^2+c^2}} \begin{pmatrix} 0 & a & -b & -c \\ -a & 0 & c & -b \\ b & -c & 0 & -a \\ c & b & a & 0 \end{pmatrix} \qquad \textbf{(73)}$$

We need to prove that if $W^k = \begin{pmatrix} r_0 \\ r_1 \\ r_2 \\ r_3 \end{pmatrix} = \dfrac{P*^k}{\sqrt{\sqrt{(P_k P*^k)(P*_L \ P^L)}}}$ **(74)**

then indeed we can describe any perpendicular vector by spanning the 3D perpendicular space to (4),

$$\begin{pmatrix} 0 & a & -b & -c \\ -a & 0 & c & -b \\ b & -c & 0 & -a \\ c & b & a & 0 \end{pmatrix} \begin{pmatrix} r_0 \\ r_1 \\ r_2 \\ r_3 \end{pmatrix} = a \begin{pmatrix} r_1 \\ -r_0 \\ -r_3 \\ r_2 \end{pmatrix} + b \begin{pmatrix} -r_2 \\ -r_3 \\ r_0 \\ r_1 \end{pmatrix} + c \begin{pmatrix} -r_3 \\ r_2 \\ -r_1 \\ r_0 \end{pmatrix} \qquad \textbf{(75)}$$

The latter is a linear combination of vectors perpendicular to (73). Therefore (71) defines a force theory. Obviously $AA^t = (a^2 + b^2 + c^2)I$ where I is the identity matrix and the determinant is $\mathrm{Det(A)} = (a^2 + b^2 + c^2)^2 = (\frac{1}{2}(U_i U *^i + U *_i \ U^i))^2$. Which quite reminds the determinant used by Abhay Ahstekar [22].

$W^k = \begin{pmatrix} r_0 \\ r_1 \\ r_2 \\ r_3 \end{pmatrix}$ is a contravariant vector and $V_i(1) = \begin{pmatrix} r_1 \\ -r_0 \\ -r_3 \\ r_2 \end{pmatrix}, V_i(2) = \begin{pmatrix} -r_2 \\ -r_3 \\ r_0 \\ r_1 \end{pmatrix}, V_i(3) = \begin{pmatrix} -r_3 \\ r_2 \\ -r_1 \\ r_0 \end{pmatrix}$

are covariant vectors. By our choice,

$$\begin{aligned} &V_i(1)W^i = V_i(2)W^i = V_i(3)W^i = 0, \\ &V_i(1)V_j(2)g^{ij} \neq 0, V_i(1)V_j(3)g^{ij} \neq 0, V_i(2)V_j(3)g^{ij} \neq 0 \end{aligned} \qquad \textbf{(76)}$$

The latter differs from Ashtekar vectors [22] because only three orthogonality conditions are required. An open question: Is $A_{\mu k}$ applicable to any W^k direction ? A clue seems to prove that $V_i(1), V_i(2), V_i(3)$ are space-like and for the non relativistic limit to show that,

$$\begin{pmatrix} 0 & a & -b & -c \\ -a & 0 & c & -b \\ b & -c & 0 & -a \\ c & b & a & 0 \end{pmatrix}\begin{pmatrix} 1 \\ \gamma\beta_x \\ \gamma\beta_y \\ \gamma\beta_z \end{pmatrix} =$$
$$a\begin{pmatrix} \gamma\beta_x \\ -1 \\ -\gamma\beta_z \\ \gamma\beta_y \end{pmatrix} + b\begin{pmatrix} -\gamma\beta_y \\ -\gamma\beta_z \\ 1 \\ \gamma\beta_x \end{pmatrix} + b\begin{pmatrix} -\gamma\beta_z \\ \gamma\beta_y \\ -\gamma\beta_x \\ 1 \end{pmatrix} \cong \begin{pmatrix} 0 \\ -a \\ b \\ c \end{pmatrix} \cong \begin{pmatrix} 0/C^2 \\ (a_x \pm g_x)/C^2 \\ (a_y \pm g_y)/C^2 \\ (a_z \pm g_z)/C^2 \end{pmatrix} \quad \textbf{(77)}$$

Such that $\gamma = \frac{1}{\sqrt{1-v^2/C^2}}, \beta_x = \frac{dx/dt}{C} = \frac{v_x}{C}\, etc.$ where C is the speed of light, v the speed, as acceptable usual annotations in the special theory of relativity and accelerations are a_x a_y and a_z. The classical limit of our square curvature of the gradient of upper limit of measurable time back to near big bang event or events, should be α^2/C^4 where a^2 is $\alpha^2 = (a_x \pm g_x)^2 + (a_y \pm g_y)^2 + (a_z \pm g_z)^2$ where (g_x, g_y, g_z) denotes the classical gravitational acceleration. If we want to measure acceleration in length units then, $\frac{d^2x^k}{(Cd\tau)^2}$ is simply the expression of the acceleration vector by differentiation by length, which is the source of the term α^2/C^4.

Conflict of Interests

The author declares that there is no conflict of interests.

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